EGYPTIAN ARCHITECTURE

FLINDERS PETRIE

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BRITISH SCHOOL OF ARCHAEOLOGY IN EGYPT

In return for 1 guinea sent in aid of the School (to University College, Gower St.), a copy of this book will be dispatched, post free, together with a copy of THE MAKING OF EGYPT, large 8*vo*, 87 *pls*. This new volume traces for the first time the origin of each of the incoming civilizations during five prehistoric periods and thirty dynasties.

EGYPTIAN ARCHITECTURE

SCOPE OF ARCHITECTURE

1. IN DEALING with ancient architecture, it should be looked on in the same spirit as that of the original builder, just as we should look on ancient literature with the eyes of the writer. To treat the labours of earlier times as if they belonged to yesterday is to miss the true meaning, and confound our judgment. The ancient builder planned something beautiful because it was natural to him, not because it was expected that he must dish up some stock subjects in an orthodox manner. He met his circumstances without any false shame in doing what seemed best, and the nearer he lived to the time of real growth and life, the more readily he gave effect to his true spirit. The great builders were artistic engineers; as Vitruvius says, " Architecture consists of three branches; namely, building, dialling, and mechanics. Building is divided in two parts. The first regulates the general plan of the walls of a city and its public buildings; the other relates to private buildings." Thus what we call civil and mechanical engineering, town-planning, monuments, and housing, are all parts of Architecture. Those who would look on Architecture as purely artistic, like painting, must remember the motto of the British Architects, where *Usui Civium* comes before *Decori Urbium*. The first duty is to fulfil the purpose of a building by attention to its uses, its parts, its proportions, its lighting; secondly, to adapt its outer appearance to its surroundings. These principles have guided all great

architecture, and it is only in the recent centuries of archaistic imitation that blind copying has ruled instead of natural growth. True Architecture is concerned with the materials available, their qualities and strength, the methods of building, the structural forms, their artistic application, and the whole as used to produce the utility which is sought for the purpose required. Each of these should be taken into account in looking at Architecture in Egypt.

The aspects which have claimed most attention hitherto have been summarized, but detailed attention is given to those matters which are less known, and especially the origins and earliest forms; these have been least regarded in the few books dealing technically with the subject. As most readers will be familiar with some of the many fine picture-books of Egyptian monuments lately published, it was not needful to repeat the popular illustrations here but only to show details required to explain the subject. It is, in large part, derived from my own observations, with examples from my excavations and from those of the British School of Egyptian Archaeology.

CHAPTER I

BRICKWORK

2. IN EGYPT, brickwork long preceded stone architecture, the forms of which grew from uses of mud bricks and reeds. The first matter to be understood therefore is the production and structural growth of brick building.

MATERIALS. The bricks were made of Nile mud, with varying proportions of sand or straw. They were sun-dried, and were very rarely fired until the Roman age. The fine black mud of the Nile is often micaceous, which adds to its tenacity. When dried, it is very hard and tough; cutting through it is as laborious as working soft rock, and bricks may be rolled down a brick pyramid without losing their shape. The mud, if unmixed, contracts much on drying, losing about an eighth of its former size when damp, as may be seen in dried-up ponds. It is therefore needful to mix it with sand, using enough to form a continuous frame of sand all through the mass, so as to prevent contraction. Otherwise chopped straw is mixed in it, enabling the mud to shrink locally around the hollows, and so dry without contracting the dimensions. The surface of the bricks is also strengthened by rolling the clay in straw dust before moulding, thus forming a thatch to resist the rain. Heavy rain will wash out the mud, leaving a matting of straw on the face, which resists any further denudation. In parts of the country where there is not much cultivable land, and the desert is near by, the bricks were made partly, or wholly, of yellow marl and pebbles. The early dynastic bricks were made of black mud alone.

3. MAKING. The bricks were, and are now, always moulded in a wooden frame with a handle at one corner (fig. 1). In the photograph of modern brickmaking (fig. 2), the man on the right kneads the mud with sand or straw, and brings it to the moulder looped in a circular palm-leaf mat; two of these are on the brick heap behind him. The moulder dips his hand in the water jar which stands before him and hews off a lump of the mixture by driving his hand forward into it. He then rolls the lump in chopped straw, so as to coat it and prevent it sticking to the mould into which it is cast; it is then flattened down and smoothed. The mould held by the left hand is next wriggled to compress the sides of the brick and loosen it, gently the mould is lifted off, and the brick left lying on the ground, with just the thickness of the mould between that and the previous brick. The ground is thus covered with rows of bricks left to dry. After about three days they can be turned over, in two days more they are set on end, and within a week they are loosely stacked together, as seen in the background of the view. If used for building as soon as this, they are liable to crush by their own weight; the brick graves at Abydos around the tomb of Qa, and the storeroom walls of Kho-sekhemui (ist and iind dyn.), had bulged out so much at the bottom as to cover many objects in the chamber, owing to the walls being built too hurriedly after the king's death.

An ancient scene of brickmaking, in the time of Tehutmes III (fig. 3) shows the long past of the present method. At the top, on the left, there is the tank, from which water is being drawn to mix the mud. Next is the man mixing it with a hoe. Another man is loading a porter with the mud in a pan. Two men are moulding bricks in moulds with a handle, laying them down side by side in close rows, exactly as is done now. When dry, they are carried off in slings from a shoulder-pole, a mode of conveyance which the Egyptian has now lost.

4. SIZES. The sizes of bricks varied much in Egypt, the largest being fifteen times the weight of the smallest. From comparing those of many different sites, we can trace a general increase from the ist up to the xvth dynasty; then a fluctuation onward to the xxvith dynasty, followed by a steady decrease till Arab times. In the following list, the size in inches of the largest and smallest class of each period is named.

Dyn.	Crude Brick	Maximum	Minimum
Prehistoric,	Nubt	13·0 × 6·0 × 3·2	11·0 × 4·5 × 3·0
i	Royal Tombs	9·9 × 4·9 × 3·0	8·8 × 4·4 × 2·9
i	Abydos	14·2 × 7·0 × 4·5	9·0 × 4·4 × 3·0
ii	Royal Tombs	10·5 × 4·9 × 2·9	
ii	Abydos	12·7 × 6·0	9·6 × 4·6 × 2·3
iii	,,	13·0 × 6·3	12·4 × 5·6 × 3·0
iv?	Nubt	20·6 × 10·3 × 6·7	
v	Abydos	12·5 × 6·2	11·5 × 4·3
vi	,,	15·7 × 7·7 × 5·7	11·5 × 5·6 × 3·2
xi	,,	12·2 × 6·1 × 3·4	10·7
xii	,,	14·3 × 7·7 × 4·3	13·7 × 7·0 × 4·1
xii	Kahun	11·2 × 5·6 × 3·4	
xii	Dahshur	16·1 × 7·9 × 4·8	14·9 × 7·2 × 4·0
xii	Hawara	17·7 × 8·8 × 5·4	
xv	Yehudiyeh	18·1 × 8·5 × 4·4	
xv	,,	16·2 × 7·4 × 4·5	14·0 × 6·5 × 3·2
xviii	Retabeh	15·4 × 7·5 × 5·4	
,,	Abydos	23·6 × 12·1 × 4·5	
,,	,,	18·0 × 9·0	12·5 × 5·9 × 3·6
,,	Nubt	16·0 × 8·0 × 4·7	15·0 × 7·0 × 4·5
xix	Ramesseum	16·2 × 7·2 × 4·4	14·9 × 7·1 × 5·1
xxi	Tanis	18·0 × 8·4 × 6·1	16·1 × 7·0 × 5·0
,,	El Heybeh		16·2 × 7·1 × 4·1
xxvi	Memphis	18·2 × 9·1 × 6·0	17·4 × 8·4 × 4·8
,,	Defenneh	17·4 × 8·2 × 4·9	13·2 × 6·8
,,	Thebes		13·7 × 6·7 × 4·4
xxvi to Ptol.	Naukratis	14·6 × 7·8 × 5·0	11·8 × 5·7 × 4·0
Ptol. IX.	Thebes	12·6 × 6·2 × 4·3	
Ist cent.	Dendereh	12·0 × 5·7 × 3·8	
Vth cent.	Kom Fares	8·4 × 4·2 × 2·6	
	Burnt Brick		
xix	Nebesheh	12·6 × 6·2 × 3·2	
xix?	Defenneh	13·5 × 6·2	
Rom.	Dendereh	11·7 × 5·4 × 3·1	
,,	Saqqareh	9·8 × 4·5 × 2·6	
,,	Sidi Mislim	8·4 × 4·0 × 2·1	
Arab,	Fayum	7·3 × 3·9 × 2·8	

It will be seen that all of these bricks are half as wide as the length, also the width may be greater than half the

length, in the proportion 3 : 2, or 4 : 3. This was by no means the rule across the Palestine border, where square bricks are common. Sometimes an exceptional start has been made in Egypt, as 14·2 in the ist and 20·6 in the ivth dynasty. Probably the royal brickyards made larger sizes for public buildings, as labour was freely used there to handle heavy weights. The largest brick here, 23·6 × 12·1, is exceeded by a size at Gerar in Palestine, 25·0 × 11·5 × 5·0, which would weigh over a hundredweight, and need two or three men to move it without breaking the edges.

5. Mortar. The binding material is identical with that of the brick. The same mud and sand, often obtained by breaking up brickbats, is trampled into a thin paste (anciently mixed with a mortar rake, fig. 4), and then poured out along the wall, ready to receive the bricks. In modern times the art is to drive the brick with a swing, down and against the next brick, so as to push up the mortar to form the vertical joint, and press in both directions for contact with the building. More thin mortar is then dashed into the joint on both sides, and smoothed off by hand. Thus bricks can be laid at over a thousand an hour, with one boy to hand them, one to mud the joints, and two to pile as much mud on the wall as can be persuaded to lie on it. The larger sizes of ancient bricks would need two hands to lay them, and must have been placed more deliberately.

Another method of laying, for foundations, and for great masses such as pyramids, was in loose sand. This had many advantages, as we shall notice farther on.

6. Plastering. A different quality of mortar was needed for the surface plastering. A wall of mud brick exposed to rain will soak it in, for a foot or two from the top, with little harm. But if water runs down in a stream, however small, it will rapidly cut through the bricks. The wall requires a firm face for its protection,

and such a face is an essential part of its strength. An unplastered brick wall will readily rock to and fro, owing to the softness of the crude brick ; but with a coat of mud plaster on each face it becomes a girder with two faces and solid ties between. The facing plaster requires to have as much sand in it as it will carry ; the grains should be all in contact, and the mud only enough to fill the interstices and make a cup for each grain. Such a face will bear heavy rain and dry again in a hot sun without damage. Samples of the plaster are laid out to dry while mixing, so as to test whether they will crack and need more sand, or crumble and need more mud. Chopped straw is often used, and serves like the straw in bricks before described : but there is no trace of the use of straw thatch, as the straw was always chopped upon the threshing floor.

The plastering was smoothed with a wooden float (fig. 5) cut out of one block, and the figure of the float became the hieroglyph of going around, and of completion, as a plasterer goes round and finishes a building.

The foot of a wall was protected from the drip of rain by a sloping line of headers to shoot the wet far out (Kahūn, pl. iii, fig. 6), and this construction of wall was copied in basalt by Ramessu II (fig. 7).

7. Bonding. The usual rule in laying bricks was alternate courses, headers and stretchers (now known as English bond). Alternate courses (fig. 8) were used from the 1st dynasty till Roman times. Exceptions are found, as in two courses of headers and two of stretchers (Retābeh), or three courses of stretchers and one of headers (Kahūn), or headers on edge between courses of stretchers (Semer-khet tomb), courses of headers tilted diagonally in order to make up an exact level, and courses of bricks laid askew in plan to give a form of binding (Kom Ombo). Sometimes bricks were spaced apart (Kahūn), probably to leave ventilation (fig. 9). Courses

of rushes were often laid, in great town walls of the Delta, as at Buto and Sais. These helped to bind the wall and to dry the interior by conduction.

Straight faces are often running through a mass of brickwork (*Dendereh*, xxix, xxxi) without any purpose. They are probably the limits of work of different gangs of men, much like dry stone walling found in the body of mastaba filling at Meydum, tomb 17. Solid mud filling was rarely used ; the only instance on a large scale is the mastaba of Nefermaot at Meydum, but he was fond of experiments, as in his inlayed colours. *Pisé* walls of rammed mud were little, if ever, used in Egypt, and only in the earliest stages of Gerar, and in the xixth dynasty at Bethpelet, Palestine.

The space between houses was filled with a junction wall to prevent access. The Egyptian was very particular not to encroach on the wall of his neighbour, and houses have separate walls touching one another.

8. Batter of Faces. The outer face of a brick wall had usually a light batter, but the inner face was always vertical ; even a fragment of a wall suffices to show the difference of its sides. The mastabas of brick and stone had more batter, rising usually at an angle of 4 on 1, or 76°. The laying out of a building with sloping sides, on an irregular foundation of varying level, appears a complex matter. The Egyptians at the end of the iiird dynasty had adopted a perfectly true and simple method for this construction. Outside of the farthest corners of the site for building they set up four vertical hollow-corners of brick walling, like the corners of a tank to contain the building (fig. 10). On these walls they drew a level line for the final ground level, and other horizontal lines at each cubit downward. Then vertical lines were drawn at the distance apart of the intended length and width of the building on the final level. All of these lines were in red. From the intersection of the verticals

with the top ground level, slopes were drawn on the walls downward, as traces of the walls at the intended angle, 76°. Then the Mastaba was built with the sides sloping in the plane of the pairs of sloping lines, one at each end. It was only needful to place the eye in the line of slope up one wall and sight across to the opposite slope, to see if the building were in the required plane.

9. Wood in Brickwork. In the early brick building of mastabas and forts (Meydum no. 17, Rahotep ; Semneh) branching trunks of trees of the *sont* (*Acacia nilotica*) are found introduced, before the building, with the bricks laid around them, a survival apparently of building around trees. Straight beams were very rarely let into walls, as foreign wood was too costly to be thus used ; but it is usual in Arab times as a bond or tie.

10. Foundations. For brickwork there were but slight foundations, in ancient as in modern times ; one or two courses under the surface were quite sufficient. At Gerar, however, Shishak had sometimes as many as six courses. A uniform substratum was needful ; hence, if the rock were to be reached, a part of the walls might have to be carried deeper. Mastaba 17 at Meydum has its brick corners at 3, 4, 5, and 21 ft. deep respectively. Sometimes bricks were laid on sand, and with sand between them. Such layers of sand enabled the levelling to be adjusted, and allowed for shifting of the soil without cracking the walls.

11. Earth Movements. The changes in level and dimensions of the soil, due to the rise and fall of subsoil water by the inundation, are very noticeable at present. When dry old land, never irrigated in modern times, is soaked for cultivation, it rises as much as twenty inches. As Nile mud contracts about an eighth in drying, the rise implies that the soil was dry down to about 14 ft. Large cracks open in dry fields, enough to entrap one's foot in walking, and anything dropped is lost. Modern build-

ings of brick and cement always crack at intervals, even if founded on the desert. As the range of temperature would make a difference of 1 in 5,000, this would cause a crack of a quarter of an inch at every hundred feet, if on a rigid base. The modern Egyptian uses salt material in his best bricks, so that they shall not become quite dry and hard; thus they can yield to and fro with the strain of movements (Richmond, *Journ. R. Inst. Brit. Archit.* XVIII, 544).

The ancients followed two methods to avoid distortion by the soil. One way was to bed on sand, which left walls free from shifting below it. The other way, for long enclosure walls, was to build them wavy or corrugated (pl. v, fig. 11). The length of such walls exposed them especially to contortions of the soil; the wavy plan allowed of rise and fall in different parts, without doing more than slightly increasing or diminishing the amount of wave in the upper part of the wall. This form also ensured the greatest steadiness with a given amount of bricks. The wavy walls are always thinner than the straight walls of enclosures.

12. Pan-bed Building. A special feature of the Egyptian brickwork is the sagging of the bed in a concave curve, so that all the courses follow as concentric coats (figs. 12, 13). This is associated naturally with the batter of the faces of the wall; but the slope of the bed may be even more than that of the batter, so that the bricks have sometimes to be advanced outward as courses ascend (fig. 14). This sag bed extends in both directions inward and along the walls; in fact, the courses may be regarded as concentric coats of a pyramidal segment of a sphere, whose apex is, perhaps, a quarter of a mile high. The purpose of this concave bedding was to hold in the corner bricks at the ends. In Gerar, blocks of stone were sometimes put up the edges for the same purpose. The curvature was certainly not an accidental settlement, as the bed

is carefully prepared by building up the corners, and at Philae a massive stone bed is laid out in a pan-curve as a foundation for the brick wall (pl. iv, fig. 15). (Choisy, *L'Art de bâtir chez les Egyptiens*, pl. 1.)

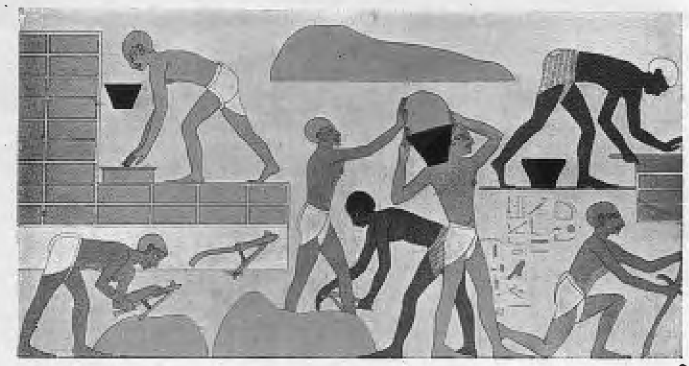
13. Sag and Straight Walls. A very peculiar type of building is seen in the great city walls, which consist of separate blocks of building, alternately with a pan-bed and a straight-bed (fig. 16). Sometimes the straight part hogs upward in the courses, but they are never so much curved as those over the pan-bed. An attempt has been made to account for this form, by the need of preventing the wall from sliding on a wet sloping foundation. But this form is found where there is neither wet nor slope, as at Abydos, Deir el Medineh, and El Kab, and even based on a hard rock bed at Philae. Such an explanation is therefore impossible in fact, and apparently futile in theory. The explanation seems to lie in what is the main defect of these great walls. The compression of the mass is not in an entirely rigid body; so great a volume is always slightly damp at heart, owing to moisture from below, as rock tombs cut at such a level are slightly damp if closed. Hence the pressure thrusts outward, where there is nothing to balance it on the face. The heart sinks by this yielding, more than the dry outside, and so the face becomes detached. Deep cracks are generally found running parallel to the face, about one or two feet in—that is to say, about the limit of the dry face—where it changes to the damper heart of the wall. Thus a great wall is more or less in a state of scaling, with slices, a foot or two thick, slowly parting and at last falling away. Some walls have, nevertheless, lasted remarkably well. The iind dynasty fort at Abydos stands 37 ft. high, and has only lost one layer of bricks from the face in nearly seven thousand years. But it stands on the dry desert plain, and was built with only six courses at once, and allowed to dry thoroughly.

The remedy for scaling which the Egyptian devised was to brace his wall through with a hard dry face, at every fifty feet or so. This was done by building in alternate blocks, which were left to harden before the alternate spaces were filled in (fig. 16). This in any case limited the scaling to short lengths. Each pan-bed block had, then, sloping faces which could be examined and seen to be sound dried building, before they were covered by the intermediate blocks. These latter were naturally built horizontal, as the bricks butted against the first series, and could not slip out at the end; in some instances the intermediate block even hogged upward, so as to put the bricks square to the older face. Such a difficulty and such a remedy seem to be a complete reason for this construction. Having once established a regular system, it was imitated sometimes by routine without reason, and there are cases where all the blocks were built at the same time to this pattern, as proved by different colours of bricks each running all the length at the same level.

14. SIZE OF WALLS. The great wall of Tanis is 80 ft. thick, and was entirely built by Pasebkhanu (xxist dynasty), with bricks stamped by him throughout, from the heart to the outside of it. The wall at Buto is 70 ft. thick, at Defenneh 40 ft. thick, and at Nebesheh (xxvith) and Abydos (xviiith) 30 ft. thick.

The height of the walls has always suffered much by weathering. At Defenneh the wall has been swept off to ground level by rain and high winds. The highest wall remaining is that of the Palace of Apries at Memphis. The palace is on a platform of brickwork of cellular construction, which descends certainly to more than 45 ft. below the floor; the pillars of the palace prove that it was 47 ft. high, so there was a sheer wall in one face, over 92 ft. in height. As a baked brick wall would not carry more than 600 ft. of its own height, the unbaked bricks must have been approaching the crushing limit.

2



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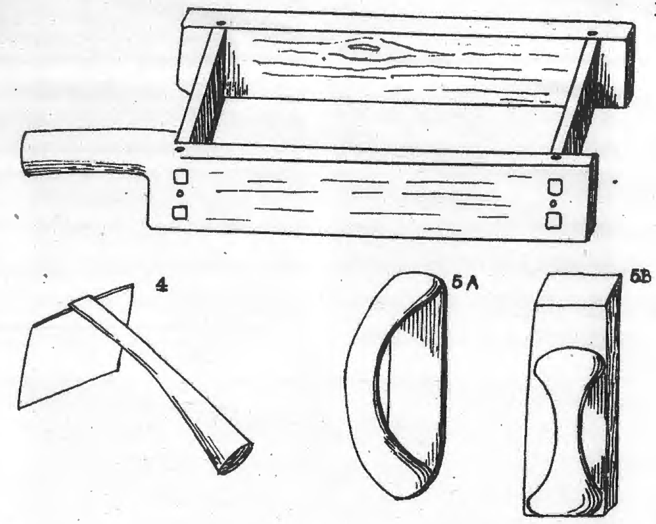
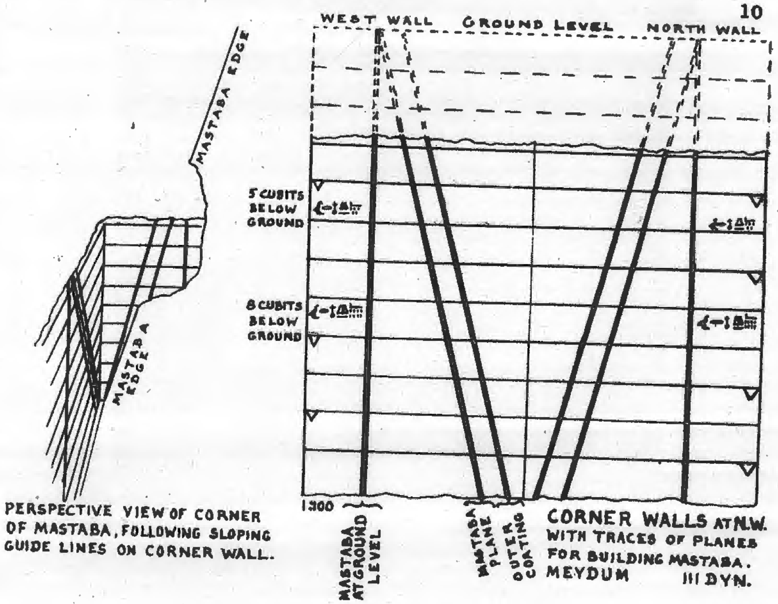


1:6 BRICKMOULD, XII DYN. BRONZE MORTAR RAKE. PLASTERERS FLOATS, XII DYN.

10



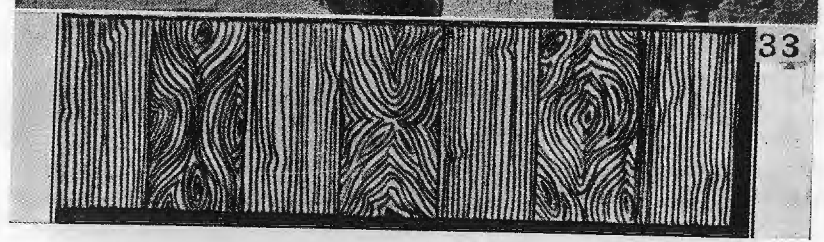
PERSPECTIVE VIEW OF CORNER OF MASTABA, FOLLOWING SLOPING GUIDE LINES ON CORNER WALL.

CORNER WALLS AT N.W. WITH TRACES OF PLANES FOR BUILDING MASTABA. MEYDUM III DYN.

WALL FOOTING ; BRICK BONDING, PAN-BED III

13

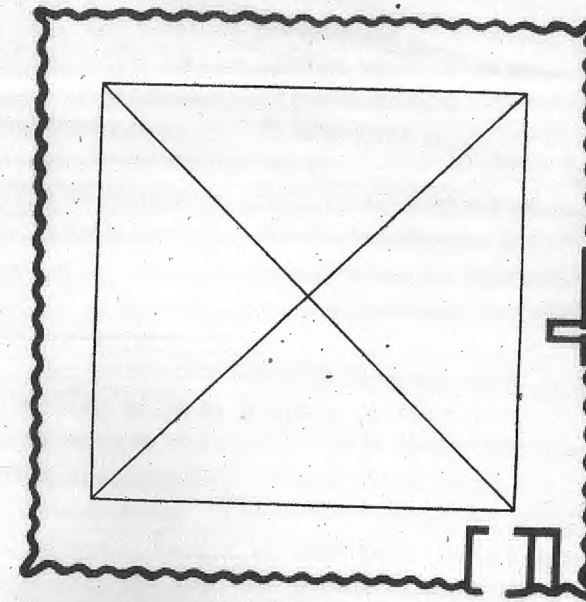
15



33

WAVY BRICK WALLS ; PAN-BED WALL ; REED FENCE V

11

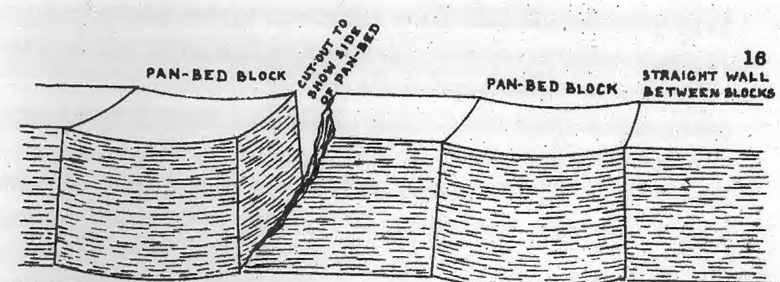


1:1000 WAVY BRICK WALLS AROUND PYRAMID, MAZGHUNEH. XII DYN.

14

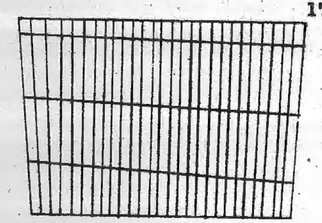
MODE OF STEPPING BRICKWORK DOWN CORNER OF PAN-BED BUILDING.

16



MODE OF BUILDING BRICK WALLS, TO OBTAIN DRY AND STRONG CROSS WALLS.

17



FENCE OF SCORPION KING

15. Decorative Brickwork. The sloping outer face of the walls had an artistic value, as it greatly diminished the heavy effect of the plain masses, devoid of windows or engaged columns. It also gave an increased sense of size by the diminution as the mass receded from the eye. This is similar to the increased effect of length in some cathedrals owing to the diminution in breadth toward the east end. The increased sense of security owing to the batter, in so soft a building material, was also a gain to the general effect.

The distinctive decoration of the early brickwork is the panelling of it as a series of false doors. This will be dealt with in the next chapter along with the influence of original materials.

Mouldings. These were made for a cornice to brick buildings. Large square thin bricks (16·7 × 16·7 × 3·0) were cut into the profile of a cornice, and built in a row on edge. They were large enough for the weight above the wall to outbalance the projecting weight; thus they stood safely upon the wall, like the sloping roof beams of the pyramid chambers. Brick cornices such as these were in use at Thebes after Ramesside times.

16. Arch Bricks. These were made with a quadrant curve cut in one corner, and placed in pairs to form a barrel roof to a passage. The name of the owner was stamped along the curve, and appeared repeated along the whole roof. Such bricks were burnt, probably to increase the strength; this may have been done intentionally after the building. Possibly the firing was only due to burning of the contents of the tomb in later times. The arch as a structural feature will be described in chapter viii.

CHAPTER II

REED, PALM, AND WOOD

17. Primitive Stages. The most primitive shelters were doubtless of organic material and, where the earliest huts of Egypt can be traced, they appear to be of bundled straw lined with mud. The organic forms had but little influence on the brickwork, but were the direct origin of the structural forms in stone. Similarly in Greece, the details of stonework were detailed copies of wooden beams and nails.

The unwrought materials which were everywhere to hand in Egypt were palm-ribs, papyrus, reeds, and mud, with palm-fibre roughly twisted as a binding material. Each of these led to some different form of construction, as may be seen in the country at present. The maize, dhurra, and rice are all of later introduction. A usual fence for cultivation, or the side of a hut, is formed by placing a row of stems close together, and lashing them to a horizontal bundle placed near the top. This is figured on the mace-head of the Scorpion King (*Hierakonpolis* I, xxvi*c*; fig. 17.) Reeds were doubtless used in the same way, when there was marshy ground unreclaimed. They are also placed between courses of brick walls to aid the cohesion and the drying.

The primitive form of hut is still to be seen in Egypt. Three sides of a shelter form a screen from the cold, and the open front is shaded by carrying the reed-stems of the roof forward and supporting them upon two columns formed by bundles of reeds. The whole is built under a tree to give a cool shade and break the force of the wind.

A similar structure is represented as a primitive shrine (fig. 18). The hut has two columns placed before it, the roof projects in front, and a low fence of pegs in the ground, lashed together, prevents animals intruding (*Medum*, ix).

Columns of reeds bound together are commonly used for support. To give greater rigidity, the bundle is plastered with mud, which prevents any bending of the stems. Such columns of frail material are even used for supporting the heavy swinging weight of a *shadūf* for raising water, as seen in the field behind the brickmaker (fig. 2). These columns originated the architectural forms, as noticed farther on.

18. Palm Rib. The mid rib of the palm branch was a favourite material in all ages for building, owing to its great toughness and elasticity. A layer of palm-sticks covered with mud is the customary roofing for country buildings. Whether native to Egypt or not, the palm has certainly been there since prehistoric ages, as the palm branch is marked on the pottery as far back as the Badarian age. The use of it for huts is seen on the ivory carving early in the ist dynasty (fig. 19), where the curved lines of the dome roof interlace as an elastic material; in the north they would be osiers, in Egypt they could only be palm ribs. Such a hut covered with palm-leaf mats is still the home of the Bisharīn tribes.

A regular fence in straight line, and the flat sides of a hut, are at present formed by planting a row of palm ribs in the ground and interweaving others diagonally both ways (fig. 20). Near the tops they are held together by lashing to a cross-stick. The whole is then plastered with mud, through which the lines of the sticks in each direction are seen in relief. This form of construction is clearly shown in the figures of shrines of the pyramid period, as in the tomb of Merab (L.D. II, 18, 19) and a slab in *Memphis* II, xviii (figs. 21, 22). The similarity of

cross-sticks in the palm-leaf fence and in the shrine is clear, and the cornice above the building is likewise formed from the loose heads of the palm-ribs. The pattern of this cavetto cornice kept the original marking of the leaves springing from each rib, down to the latest times (*see* L.D. III, 115). Moreover, on looking at sections of temple roofs, it will be seen that usually the flat roof is at the same level as the torus roll, where the cross-bundle of palm-ribs is lashed on, and so supports the roof in a palm-rib hut. The cavetto cornice thus maintains its original position, derived from the loose tops of the palm-ribs (fig. 23).

19. PAPYRUS. The papyrus was of much importance to the Egyptians but, being now extinct in Egypt, we have no modern examples of its use to guide us in recognising its derivations. The stems of the papyrus were much used in construction. Boats were made of bundles of the stems lashed together, and the thick outer layers were wrought into sails, nets, cloths, coverlets, and ropes (Pliny, xiii, 22). In early times it was so usual for constructing dwellings, that the treatment of the crown of it formed a decorative border which was copied through all the history.

The decisive example is the figure of a boat with cabins built upon it, having the *khaker* ornament along the top. This position proves that this ornament was very light, and must have belonged to the light material of cabin building (fig. 24). The form of the loose feathery head of the papyrus explains this. It was impracticable to have such a mass left loose, and when gathered together it formed a good holder for the horizontal stems used in the roofing. These stems are always shown as concentric circles put through the feathery head, which is bound together to grip the roofing stem in place. The upper ends of the mass are further tied together to keep them tidy (fig. 25), much as the loose hair of women was tied

up in the xiith dynasty (L.D. II, 126). This decorative form is earliest known as a relief from Meydum (fig. 26), which is probably of the iiird dynasty. It was usually painted along the tops of the walls in the xiith dynasty, and appears commonly down to Roman times. The use of papyrus bundles as columns started the form found at Amarna (fig. 89), where the triangular form of each stem is curved. These are described among forms of columns.

20. RUSHWORK, though not constructional in building, was used for ornament. A fine instance of painted matting is on the ceiling of a tomb (*Benihasan* I, vi). An oblong space in the middle of the roof is represented as covered with plaited mats of various patterns. Perhaps also the ceiling pattern itself has been derived from matwork; this is suggested by the varieties seen in a neighbouring tomb (L.D. II, 130).

21. WOOD was largely used in early constructions. In the ist dynasty the man with two axes is one of the high officials; the great royal tombs were entirely of massive timbering; and the later architecture—like that of Greece and India—shows plainly the copying of wooden prototypes. At present we think of Egypt as being devoid of useful timber, but Floyer has shown that there are evidences of the country having been far more wooded in ancient times, before the camel extirpated the desert flora. Timber was also largely imported from Syria, in prehistoric as well as historic times.

The earliest constructional use of wood that remains is in the form of sticks and poles laid across open graves. This held up brushwood and matting on which the earth was laid. Such graves were developed into the size of the great royal tombs of the ist dynasty. In the largest of these, the wooden chamber was roofed with beams up to 19 ft. span, and such beams still remaining in the floor are 11 by 7 ins. in section. If they were spaced with

intervals of three diameters they would be amply strong for the load. They were doubtless covered with boards, and matting of plaited palm-leaf overlaid these, to prevent the top layer of sand running through. The cast of the matting remains on the top of the brick lining of the pit. The sides of the royal tombs were formed of upright planks of wood, three or four inches thick, which stood on ledges in the massive wooden floor.

Another form of roofing was by round palm-trunks placed side by side. These prove that wood was not very scarce, when it was so wastefully used. This roof was copied in stone for the ceiling of a rock chamber in the west side of the area round the Second Pyramid, also in the rock chamber of the tomb of Senusert III at Abydos.

22. WOODEN HOUSING. The most regular and usual form of wood construction was for palaces and houses. First we may notice the scanty remains which have come to light, for, as the dwellings were in the plain, none of them could be found without searching far below the present water level. Fortunately old timbers of houses were employed sometimes for roofing of graves; thus whole boards have been preserved, and show us their original use (fig. 27). The house was framed of upright boards which lapped one over another at the edges (fig. 28). Thus as they expanded and contracted, by rainstorm and tropical sun, there was no gap or crack opened. So long as two boards kept flat neither wind nor sand need enter. To hold the boards together, slots were cut, not going through, but returning in the face or edge of the board; thus ties, probably of hide, could lash the boards one on the other and allow of a slide of a quarter of an inch for contraction. In this way the problem of a permanent tight joint was settled.

Next, the requirements of a great hall of a noble had to be met. His retainers naturally would sleep around him

as guards; such we know was the North European custom, and such is reflected in the girdle of graves put round each royal tomb. For sleeping on the ground the Egyptian thinks mostly of avoiding draughts, and weather-tight recesses all round the great hall were provided for sleeping bunks between the doorways which would be essential for hot weather (fig. 28A). This appears to be the origin of the in-and-out bays which form the sides of the hall (fig. 28B). The actual construction of these was by the lapping of the upright boards, and this was copied in brickwork (29), and formed the panelling in buildings which is characteristic of the early mastaba tombs (fig. 30). A house so constructed could be thrown open all along the sides by opening the narrow doors to let air blow freely through; it could be closed on either side in storms or on sandy days. When shut at night, there would be sheltered bunks, out of the draughts which would certainly cut in below the doors. Where doors were not needed for passage, they were barred across to keep out animals or thieves at night, as shown on the coffin house-models, where some are barred and some can stand open (fig. 31). A further consideration was that a house of this pattern could be readily moved so as to be on the desert during the inundation and on the plain during the dry season, being moved to and fro every year. There would be about 30 boards to each bunk, so with some farm labour each retainer could easily move his share of the hall in a day. While the desert is requisite during the inundation, the crop land is much cooler in the heat. These boards that have been found bear the weathering on the face, showing how far the lapping board protected it; in one piece the side was burnt by a fire having been lighted near it.

In other buildings the sleeping bunks were not recessed, and only a straight line of overlapped boards filled the space between the doors. This is seen on the granite

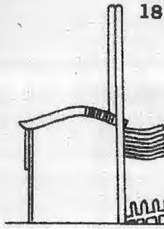
sarcophagus of Khufu-onkh (fig. 32). There the pattern had planks as wide as they could be cut from the tree, in lapping order. The main planks were higher and went to the top of the building as structural posts: shorter planks were filled by openwork carving in wood, to prevent birds from entering. At the doorway there is recessed planking on the sides. The ends of long beams, showing above all this, suggest that a floor was let in here for an upper room, with short panellings. At the top are the ends of the roofing poles, half-trunks from split trees, and laid with the flat sides downward. They are alternate, stouter ones to carry the roofing, and slighter ones filling in between. This is one of the most complete and instructive copies of a wooden palace front. Other good examples are on a fragment in *Abydos* I, xiii, 168, and a painting on the coffin of Nekht-onkh, *Gizeh and Rifeh*, xA.

23. PANELLING. The shallow relief of the panel in wood, or in stone carving, became much deeper when it was translated into brickwork, as it could only be made by the width of a brick. The actual arrangement of the bricks, to produce the form, is copied here from a mastaba at Tarkhān (fig. 30).

The roofing by means of poles is often copied in stone. Sometimes the poles are close together, as in the tomb of Methen, early ivth dynasty (L.D. II, 4) and in the eaves of a vith dynasty tomb (*Diospolis*, 37, xxv). In the tombs of Ameny and Khnumhetep at Benihasan the poles are spaced apart five times their breadth, or about a foot and a half apart, the poles being a palm in width. The rounded side is downward, as in the rock-carved ceilings.

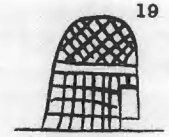
The use of wooden panelling for ornament was an early mode. The graining of wood is beautifully drawn on the wooden cylinder measures painted in the tomb of Ra-hesy (Quibell, *Hesy*, viii, x, xiii), and in a ivth dynasty tomb

18



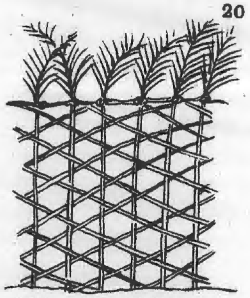
HUT-SHRINE, MEYDUM

19



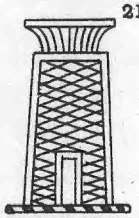
HUT I DYN. ROYAL TOMBS II, IV.

20



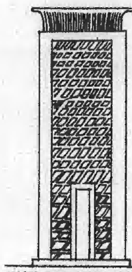
MODERN FENCE OF PALM-STICKS

21



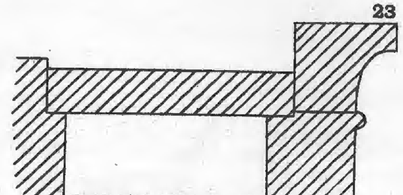
HUT-SHRINE, IV DYN. MERAB. L.D. II, 19.

22



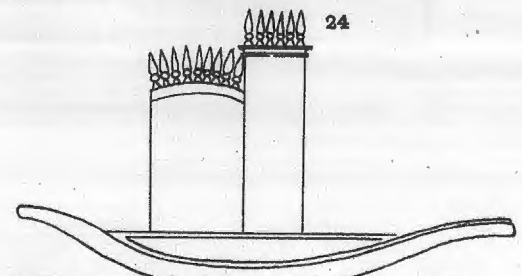
HUT-SHRINE, V DYN. MEMPHIS II xviii

23



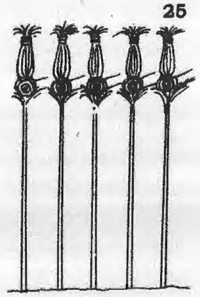
ROOF AND CORNICE, SETY I.

24



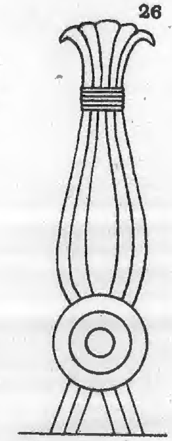
BOAT CABINS WITH KHAKER. PTAH-HOTEP, V DYN. L.D. II, 101

25



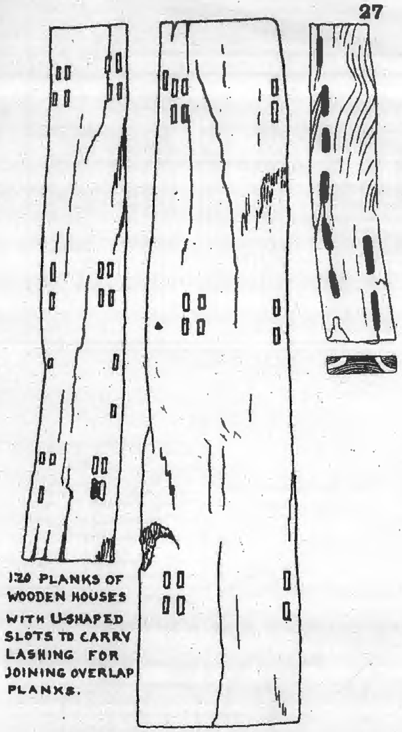
PAPYRUS STEMS TIED UP AS SUPPORTS

26



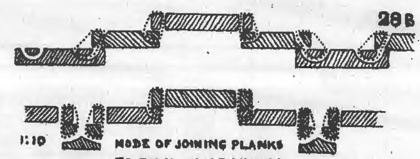
KHAKER. MEYDUM, III DYN.

27



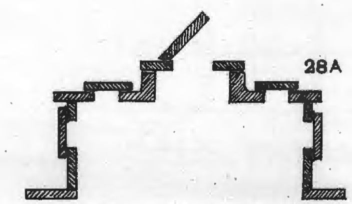
1:20 PLANKS OF WOODEN HOUSES WITH U-SHAPED SLOTS TO CARRY LASHING FOR JOINING OVERLAP PLANKS.

28B



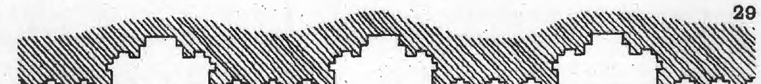
1:10 MODE OF JOINING PLANKS TO FORM WOODEN HOUSE.

28A



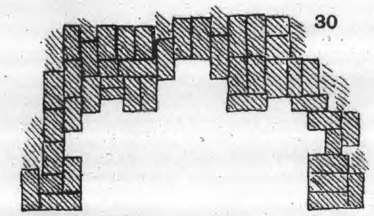
1:20 OVERLAPPED PLANKS FOR DOORWAY, THE SOURCE OF BRICKWORK FORMS BELOW.

29



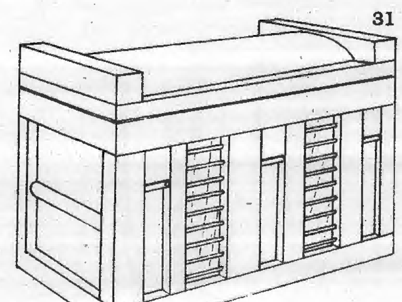
1:60 PART OF MASTABA FRONT COPIED FROM WOODEN HOUSE. TARKHAN, I DYN.

30

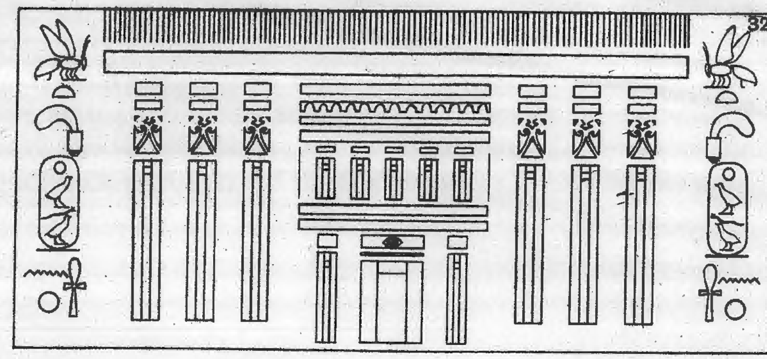


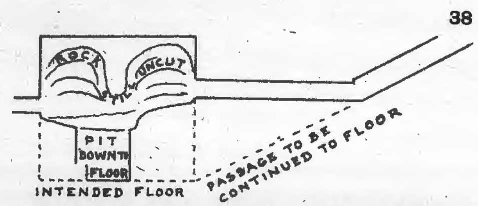
1:20 MODE OF LAYING BRICKS TO FORM RECESSES AS IN TOMB WALL BELOW.

31

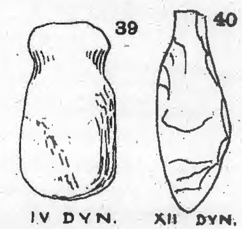


WOODEN COFFIN, COPIED FROM WOODEN HOUSE.

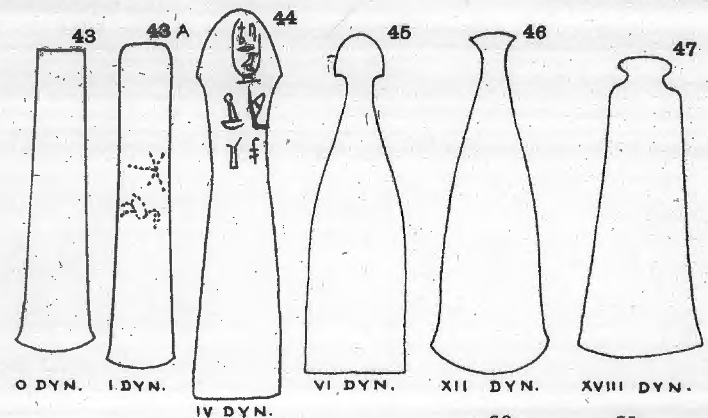


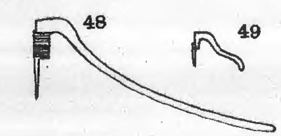


1:400 UNFINISHED ROCK CHAMBER. KHUFU, IV DYN.

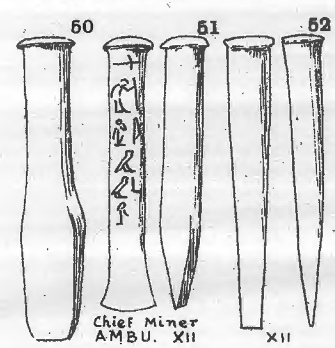


1:6 STONE MAULS.





1:40 LARGE AND SMALL ADZES WITH HANDLES.



(fig. 33) there is careful painting representing a wainscot of variously grained wood (L.D. II, 19–21).

We have here dealt with the material for construction; the actual buildings and plans will better be considered with the temple plans, as the temple was the house of the god, each part derived from a house for the living persons.

CHAPTER III

STONEWORK

24. MATERIALS. Egypt abounds with excellent stone of very different qualities. The Egyptians, having the convenience of water transport, never had a mile of road between quarry and building. The natural facilities for architecture were unsurpassable. The cultivation of the land likewise favoured monumental work; during half the year scarcely any agriculture was possible, owing to the dryness, and then the submergence of the soil. Thus the inhabitants could be employed on public works without the least detraction from productiveness, but with great gain to their training in skill and co-operation.

Limestone. The main part of Egypt is a limestone plateau through which the Nile Valley is cut. This stone is of the Eocene age and varies much in character. Some is as fine grained and amorphous as chalk, and scarcely harder than strong chalk. This is an exquisite stone to work, as it can be flaked and broken with certainty almost exactly as desired. It comes mainly from the quarries of Gebel Mokattam and Turra, between Cairo and Helwan, and was used for the casing of the pyramid of Khufu, and the tomb sculptures of the pyramid age, the iiird to the xiith dynasties. The quality used by Zeser in the iiird dynasty at Saqqara is brittle and not in large blocks. Though of fine grain it was used in a tentative way, with compound columns supported by side walls.

Rather harder limestone is also found, some yellowish and splintery as used on the pyramid of Khafra; other kinds creamy and very fine grained, but fragile, as at

Thebes. A coarser limestone contains a large quantity of crystalline nummulites, and is strong for bearing weights, but will not dress well. It came mainly from Mokattam, and is found along the Nile side; it was used for the core of the Khufu pyramid, and the great enclosure walls near by.

In various places, especially near Amarna, a limestone is found which has been so consolidated by infiltration that it is changed to a compact and hard marble. This was a favourite stone for statuary and the best inscriptions, as in the xiith dynasty at the Labyrinth, and in the xviiith dynasty under Amenhetep III at Thebes. The other principal limestone quarries are at Surariyeh, lat. 28° 20′; Zoweydeh, 28° 5′; Sheykh Timay, 27° 51′; Sheykh Sayd, 27° 42′; and Gebel Abu Foda, 27° 30′.

Alabaster. This is found in thick masses in the limestone, and is entirely due to solution of the rock by rain, and redeposit of the carbonate of lime in crystalline layers on the sides of waterworn caverns. The successive coats of deposit can always be traced in it. The great historical quarry is at Hatnub, east of Amarna (27° 34′). The age of working there is shown by the names of Khufu, Pepy I and II, and Senusert I. The quarry is open to the sky, being a large pit with a sloping descent. Another quarry is said to be behind Daūdiyeh, lat. 28° 9′. The qualities of alabaster vary much. That used in the early dynasties is very fine grained; beside being utilised much for dishes and vases, enormous blocks were moved for building, as at the Granite Temple, Gizeh. In the xiith dynasty, a honey-yellow variety was generally used. In the xviiith dynasty, more crystalline kinds appear, white and fairly translucent. In the xxvith dynasty, a dull opaque variety was common, often with bands of brownish white. All of the true alabaster (anciently so named) is carbonate of lime, as hard as marble, and not the softer sulphate of lime, gypsum, which is now called alabaster in Italy.

Granite. The red granite of varied quality comes entirely from the great eruptive belt at the First Cataract. It was wrought in the middle of the ist dynasty, as early as the reign of King Den, who had a floor of granite in his tomb. Enormous masses were used for paving in the unfinished tomb of Nebka (iiird dynasty). Under Khufu, beams of 40 to 80 tons' weight were freely cut, forty-three such forming the roofs of his chamber, and a furlong length of blocks, uniform in gauge, serving for the walls and floor. The earlier working is all of waterworn and rounded blocks, dressed to shape; such were of safer material, as any cracks were certain to have opened by weathering and so become visible. In later ages, the rock was quarried out of the solid mass, and an unfinished colossus of Amenhetep III proves the age of such working at Aswān. The quality varies; dark red was used in pyramid times, a medium red with small green spots under the xiith dynasty, pale red with large crystals under Ramessu II, a coarse full red in the xxvith dynasty, and a rather lighter colour in Roman times. The black granite was used by the Uah-ka princes of the ixth dynasty, and for the fish-offerer statues; a grey granite was fashionable in the xiith and again in the xxvith dynasty. As a rule, the work of the black granite school is always the finest, for instance on the pyramidion of Amenemhat III at Cairo.

Sandstone. The soft Nubian sandstone was greatly quarried, from the xviiith dynasty to Roman times, at Silsileh, lat. 24° 40′; this is the northern edge of the great sandstone region which extends thence through Nubia, only broken by the granite ridge at Aswān. Other quarries were worked at Gebel Hamam, 24° 15′; Kalabsheh, 23° 28′; and Meroe, 16° 52′. The stone is weak, and it is impossible to do any fine work with a grain so coarse and so friable; the free use of it led to great degeneration in workmanship. Dark brown sandstone

was occasionally used in the xith (Abydos) and in the xiith dynasty (Koptos).

Quartzite is only found at two places; at Gebel Ahmar, two miles east of Cairo, there were some hot springs, due to volcanic action, like the basalt some miles to the north; these springs have cemented together the sand of the desert into an immense mass of silica, with very slight porosity. The stone is stained by iron with every colour, varying from white to yellow, brown, pink, and purple-red. The red tints have probably been brown, but changed by volcanic heat. The hill has been quarried away, from the time of the ivth dynasty onward, and immense masses were taken in the xiith and xviiith dynasties, so that there is now hardly more than a mass of chips about eighty feet high. In the heart of it is a small nucleus which is still worked for millstones (Clarke, Engelbach, *Anc. Eg. Masonry*, figs. 31–33). The pebbly sandstone conglomerate used for the colossi of Amenhetep III at Thebes is stated to come from near Gebeleyn.

Basalt of a dark brown colour occurs as a thick bed at Abu Zabel and Khankah, about fifteen miles north of Cairo, where it is still worked largely for road metal, by convict labour. The first great use of this stone was for the paving of the temple of Khufu's pyramid, where it covered more than a third of an acre, entirely of sawn blocks. It was also used for the edges of one of the small pyramids of Khufu. It rarely appears after the Old Kingdom.

Black basalt occurs in the columnar form in the desert west of Behnesa: small columns of black basalt were used at Ehnasya (*E*, p. 15). Basalt beds also occur northwest of the Fayum.

Greenish basalt of fine grain was much used for statuary, but it is difficult to distinguish in finished work from metamorphosed volcanic ash, or slate. The statue of

Tehutmes III in Cairo, and the splendid head of Greek age at Berlin, are well-known examples of statuary in this stone, but the source of it has not been discovered.

Diorite probably came from the desert south-west of Aswān. It is mostly translucent, and consists of felspar with schistose streaks of hornblende and some dolomite, apparently metamorphic. It was used for the finest work in the Old Kingdom, statuary, bowls, and vases; the edges of one of the Khufu pyramids were cased with diorite.

25. Quarrying

Limestone. The essential principle in Egyptian quarrying was the cutting out of the stone from the rock, carefully avoiding the natural joints. An Egyptian quarry is not a shapeless hole; it is an orderly workshop where fine material is removed as regularly and evenly as wood taken out of store; this can be seen in action at Helwān. The grand quarries of Turra follow the good beds of limestone, leaving regular pillars in rows to hold the roof. The same is seen in the south, at Qau (pl. ix, 34, 35). Attack on a face was made by starting at the top, cutting vertical and horizontal grooves inward round an intended block, and then cracking it out. Lines of red paint marked on the roof each successive front of the working face. When the quarryman was once on a ledge he cut downward, and then cut under each block to be detached, removing it wrought on all sides. For blocks that were too large for the workman's arm and his pick to cut the whole face, a narrow passage was worked out of the rock around the block, for the quarrymen to pass (36). For pillars, blocks were cut vertically (37), so that the bedding should be correct.

Sandstone. The great example of precision was at the sandstone quarries of Silsileh. Large cracks intersect the rock; but instead of working in from the fissure

where the rock was damaged, the cracks are left strictly untouched, with walls a foot thick on each side; deep quarry pits are worked out twenty or thirty feet deep, between the unbroken sides of cracks. Thus the deteriorated faces, hardened or rotted, were left unused.

The regular use of trenches for cutting out rock is seen behind the pyramid of Khafra. The trenches are parallel, crossing squarely, 20 ins. wide, leaving 109 to 112 ins. of rock between them for removal.

Granite. For quarrying blocks of moderate size, a groove was worked out about an inch deep; along this, deeper holes were jumped, at about two feet apart. These may be seen on the backs of the granite roofing beams of Khufu and Menkaura. There is no trace of the crushing by wedges, in these holes, nor any green stain of copper. Two methods of splitting granite are known in India, one by dry wedges of wood driven hard and then wetted, the other by heating the granite along the groove by fire, and suddenly quenching it with water. The deeper holes cut by Egyptians at intervals indicates that the wetted wedges were used. For modern Italian methods of wedge-splitting, see *Ancient Egypt*, 1916, p. 110. Larger masses, such as obelisks, were cut out by pounding a trough along the rock, using stone ball hammers, probably set at the end of long handles, a form like a pavior's rammer (Engelbach, *Problem of the Obelisks*). The difficulty remains about getting sufficiently powerful blows horizontally for the under-cut. It may have been possible to have a slow fire along the bottom of the vertical troughs, and then to flood water in, to force a horizontal crack from trough to trough.

The largest blocks of granite were the standing colossus of Tanis, about 92 ft. high, weighing about 900 tons; the seated colossus of the Ramesseum, 57 ft. high, and over 1,000 tons; the Lateran obelisk of Tehutmes III, 105½ ft. high, weighing 480 tons, and the Karnak obelisk of

Hatshepsut, 97½ ft. high, of 330 tons. The obelisk of Heliopolis is about 110 tons.

Quartzite. The sepulchre of Amenemhat III in the Hawara pyramid is the most finished piece of work, being beautifully flat and true on the inner faces, and about 26 ft. long; it weighed about 110 tons, being about two feet in thickness. At the quarry, the quartzite seems to have been cut by grooves pounded as in the granite. The Memnon colossi of hard pebble conglomerate, erected by Amenhetep III at Qurneh, weigh 1,175 tons.

The quarry marks were fixed for each quarry, and at Silsileh the mark is carved high up on the face of the quarry, sometimes in relief. These marks seem in many cases to be connected with the foreign signary found in Egypt, probably due to labour of captives in the quarries. Each block cut out was marked with the sign of the quarry, and the sources used for the various buildings can still be traced. On limestone blocks the quarry register is often painted in red, with the year, month, and day of the cutting; these blocks would have been the tallies placed with each field of blocks laid out as a store during building. The kings' names and the dates may be valuable historically as a guide to the position in the Sothis cycle of dating (see *Meydum*, pls. v, vi, and *Historical Studies*, 10–12).

26. Marking out Work. In the rock-cut passages and tombs, the system was to cut a rough driftway, smaller than was designed, and to finish the roof of it in a true plane. A red axis line was then drawn along the roof, the walls were dressed away to be equidistant from it on each side, and vertical; lastly, the floor was dressed to be parallel to the roof. This may be seen in rock cutting at Gizeh.

The same system was followed for rock chambers. It has long been a puzzle why the subterranean chamber of the pyramid of Khufu should have a finished ceiling and walls, but an entirely rough floor with a deep hole in

it (38). The meaning is seen when we recognise the regular method of rock cutting. The roof is finished, the walls are started. A pit was sunk as low as the intended floor of the chamber. Had it been finished, then the sloping entrance passage would have run on down to the chamber floor, and the chamber would have been a lofty one, twenty feet high.

The system for marking the building lines on roof beams was to draw on the beam one line for the middle, and two end lines to go over the chamber walls, and supplementary lines at one cubit from each of these in case they should be effaced. To make the positions of the lines clearer, triangles were drawn based on the lines, so that the broad patch of colour could be seen readily at a distance (*Pyramids and Temples*, 93, 94). Such triangles are shown on the cubit lines in fig. 10.

Similarly in building a brick pyramid, the work was gauged at intervals and the axis marked on it, with supplementary marks each side, as at Hawara pyramid "2 cubits from the heart (axis) of the building."

In the masonry likewise the work was all marked out in red on the side of a block, ready to cut it out in profile. The standard diagrams for a palm capital and a Hat-hor capital (fig. 101) are drawn full size in a quarry at Gebel Abu Fodeh (*Season in Egypt*, xxv.); see further, under these forms of capital, in Chapter vi.

27. Tools. The earliest tooling on stone is that on the statues of Min found at Koptos, where designs are worked by hammer-dressing the ground. At the end of the ist dynasty, the stele of Sabef was hammer-dressed (*Royal Tombs* I, xxx). Similarly the blocks of the oldest stone chamber—that of Kho-sekhemui—are partly hammer-dressed, on natural cleavage faces. The stone hammers used for dressing were discs of compact amorphous black quartz (hornstone) or compact syenite. They were held in the hand, as were also the polished

stones used for beating out metal. How the shock and jar of the blow were prevented from injuring the wrist is unknown. This system of hammer-dressing was very usual in all periods, for reducing masses to curved forms which could not be sawn out. It was mainly used on granite, and the evidence of it is sometimes seen in the whitish spots of stunned stone left visible in polished surfaces of statuary. Similar pounding work was used to hollow out the large tombs at Antaeopolis.

For dressing down stone by blows, large and heavy stone mauls were used. These were of quartzose rocks in the ivth–vith dynasties (fig. 39), and of silicified limestone or chert in the xiith dynasty, at Beni Hasan (fig. 40) and Qurneh.

The result of hammer-pick dressing is seen in ix, 41. The pointed pick of later times shows in 42. The claw tool, like a comb, is of Roman age.

For cutting soft stone, the copper adze was usual. It varied in form, flat top, rounded, or with a knob head, viii, 43–47. It was mounted by binding on to a wooden handle; a very large adze used by boat builders (iiird dynasty) is in fig. 48, and the small size used by carpenters in fig. 49. For guidance in adzing a flat face, a testing-plane covered with ochre was used.

For dressing stone, the adze was used in the chamber of Kho-sekhemui (iind dynasty), but the blade was of flint, as is shown by the chips on the edge leaving raised ridges on the stone; on the contrary, a metal tool has jagged dents on the edge which leave scores in the stone facing. The copper adze was the usual tool for dressing limestone in the ivth dynasty and onward.

Scraping was usual for finishing surfaces of limestone, especially around figures of hieroglyphs in relief. At the end of the iiird dynasty, flint scrapers were in use (tomb of Ra-nefer) and copper scrapers (tomb of Nefermaot), see *Medum*, 27.

The chisel was in use early in the ivth dynasty, but its exact starting-point is not yet known. It was usually round in the body, sloping off to a sharp edge (50–52). The main use was for reducing masses of limestone or soft sandstone; it would be quite useless upon granite. The supposed "bi-metallic" chisel (Choisy), with a bronze body and almost pure copper exterior, is doubtless due to corrosion removing the more oxidizable tin alloy from the copper to the surface, but leaving the interior unchanged; such a gradual transference of alloys, leaving a spongy mass of purer metal, is very well known.

The copper tools used during the Old and Middle Kingdoms were generally hardened by arsenic, usually ½ to 1 *per cent.*, sometimes as much as 4 *per cent.* Rarely, one or two *per cent.* of tin is also found. The hardening was due to arsenic and copper oxide, with heavy hammering, and these means will now harden copper to an edge about equal to soft steel. From the xviiith dynasty onward, bronze is usual, containing 6 to 15 *per cent.* of tin.

The mallet used for striking the chisel was always of wood. There is the club mallet shown in early scenes, and found in the xiith dynasty. The more usual form was that of the modern mason's mallet (53–56), which is found in all ages from the iiird dynasty onward.

For the work in granite and diorite, no doubt emery was used in prehistoric times and onward. Blocks of emery are found in prehistoric graves, and no other material would have ground and polished the prehistoric vases of porphyry and granite.

In the ivth dynasty, sawing and tube drilling were the habitual modes of working granite and basalt. See *Pyramids and Temples* xiv, and *Tools and Weapons* lii, for illustrations. The cuts were cleaner and more rapid than in the diamond drilling of the present time. What materials were used can only be inferred. Certainly copper blades eight feet long must have been employed,

as the cuts run the length of 90 ins. of granite. That fixed points of cutting stones were inserted is known from the emery teeth found broken off, in a saw cut in hard limestone, at Tiryns. But it seems hardly credible that emery would make so clean and forcible a cut as we see in diorite and quartz. Engineers at present declare that only bort (amorphous diamond), could cut so sharply. In our ignorance of the range of early Egyptian materials we cannot deny that diamond was used. The outlines of large hieroglyphs in granite, as on the obelisks, were cleared at the corners by minute tube drills, and then graved out by a hand-tool of copper from corner to corner, fed with emery; the middle piece was broken out, and the floor of the sign hammer-dressed, and finally polished with emery. The details of the history of tools cannot be followed here, as we only need to indicate how the stone could be worked. See the Catalogue volume, *Tools and Weapons*.

CHAPTER IV

TRANSPORT

28. The Country. The natural conditions of Egypt were most favourable for great public works. The fertility of the soil was such that one crop in the year, growing from November to April, was enough to maintain the people. By March or April, in the old system of basin irrigation, all the crops were being cleared off the ground; the people, after that, were at leisure for public works, so that levies could be raised without any hardship or loss to the country. Then inundation follows in July, and lasts over the country till the end of October. This made it easy to transport stones on boats or rafts from the quarries to the building sites. By the beginning of November every man is busy again sowing his land. Hence there was a season clear of all other labour, beginning in March or April and ending in October; so unlimited levies could be drawn for quarrying and transport of stone without impoverishing the people.

The Nile inundation usually covered the whole of the flat plain, and in shallow barges, or on rafts, stone could be brought close up to the foot of the desert. This enormously aided the supply of material, as building was hardly ever a quarter of a mile from this water carriage, aided doubtless by canals, so far as possible.

29. Shipping. The transport of ordinary building blocks is specified in some accounts scribbled on flakes of limestone, concerning the building of the Ramesseum (*Anc. Eg.* 1915, 136). The boats employed were about the usual size of cargo boats on the Nile at present, of 15

to 20 tons' burden, or 70 to 100 ardebs. Each boat carried 5 to 7 blocks ; the largest block was about 5 ft. long, the load being 40 to 55 cubic cubits. The boats floated down from the sandstone quarries of Silsileh in parties of five together. The four tablets of accounts record the sizes of about 120 stones, which is rather more than there are in the whole wall at Thebes with the scene of the Khita war. (*Stud. Hist.* iii., 43–44.)

In the sculptures of Deir el Bahri (Naville, *D.B.* cliii-iv) there is shown the transport of a pair of obelisks, about 27 ft. long and 45 ins. square, placed end to end on a barge. They were apparently not the great obelisks, of 100 ft. high and 7 ft. square, as they are shewn only a quarter of the length and half the thickness which those would have appeared in relation to the crew, and also it would be very unlikely that two such masses as the great obelisks of over 300 tons would be needlessly taken together in one load. They had been slid on wooden sledges, which remained under them in the barge. The barge was towed by three lines of ten rowing boats each. The middle line of boats had 17 oars on a side, the outer lines had 15 oars a side. There were thus 940 oars for propulsion. The obelisks were probably not lowered into the bottom of the barge, as that would greatly add to the trouble of moving them out. Judging by the methods of building, it seems likely that the boat was banked round and filled with sand while resting in stocks on shore. The obelisk was then drawn on to the sand filling, which was next basketed out, leaving the obelisks on thwarts. When the Nile rose the whole floated off. Similarly for unloading, the barge would again be filled with sand. For the forms of ships, see the article in *Anc. Egypt*, 1933.

30. HAULING. The method of moving large blocks was by dragging them on sledges, and not by rollers as in Assyria. The figure of a sledge drawn by two oxen,

bearing a stone, is shown in the Turra quarries of the xviiith dynasty. A fragment of a sledge of *sont*, the hard acacia wood, was found thrown into the chip filling of the xiith dynasty pyramid at Lahūn. A well-known picture of a colossus lashed to a sledge was formerly in a tomb at El Bersheh, now destroyed, but published by Wilkinson. (W.*M.C.*, 1878, II, 305) and Lepsius (*Denk.* II, 134). The statue was lashed by cords, over pads to prevent their marking the stone. The cords were twisted by pieces of stick until they were quite tight. The sledge was drawn by four double files of men, dragging at four long ropes tied to the front of the sledge ; there were 21 pairs of men at each rope and one leader, altogether 172 men. If we allow ten men to a ton, that would shew a maximum of 17 tons ; this would imply that the seated figure was about 14 ft. high. Three men carry pairs of water jars, while another is pouring water in front of the sledge to make the mud soil slippery. One man stands on the knee of the statue beating time for the hauling. Another is burning incense before the colossus as it advances. Seven ranks of eleven men advance toward the statue holding branches. These numbers are doubtless ten men and one head man in each rank, as the Sinai expeditions had always one foreman and ten workmen. The men are not soldiers, but of the same class as the haulers. One rank, like one row of haulers, has the long hair curly, and wears a long garment which reaches to the calf of the leg at the back.

This system of simple hauling is still found to be the most effective for occasional use, where appliances are not worth obtaining. Blocks up to a couple of tons I have had hauled up and down over a bank of high brick walling at Abydos, as the natural method to which the people were accustomed.

31. CAUSEWAYS. Where stone was required for a large building on a rise, it was then worth while to provide

regularly graded hard ways to draw it up to the required level.

To see what is practically needed, we may observe the iiird dyn. pyramid of Meydum. This was built in 17 years, as we know by the quarry dates on the casing. It consisted of about 600,000 blocks averaging 2 tons each. Now 17 years is about 6,000 working days; so 100 blocks a day had to move up to the pyramid. Suppose a 2-ton block to be hauled 2 ft. in a minute, or 120 ft. in an hour, up the sloping causeway, it would take a day to drag it up to the pyramid. Thus there would be 100 blocks in transit at once. Four files of five men each would be needed to move one block. Allowing some free space, the gangs could not be nearer than 40 ft. apart. Thus only 20 or 25 blocks could be in transit on one causeway at once. Four or five causeways would be requisite in constant use, to bring up the stones in time, and each of them crowded as closely as practicable. The men employed must have been about 2,000 for the hauling alone, continuously all the year.

At Meydum, on the east side, beside the temple causeway, which was doubtless used before it was finished for the temple, there is also the old causeway for the heaviest blocks, carefully graded in the rock. On the south I observed two lines of graded way, and one or two more on the north. Thus there were the needful five or six lines of approach for the material. We see, then, that the Egyptian must have had many causeways for each pyramid, the largest and best of which were for the great beams, while the ordinary core stones could be brought on inferior roads. All of the causeways must have been continuously occupied all the year, with as many working gangs as could act without interfering with one another.

The great causeway at Meydum is 201 ins. wide, and lined with side walls narrowing it to 123 ins. wide = 6

cubits. It had a stone paving, bedded on brickwork. The rise of it is almost 1 in 10; the sloping length is 560 ft., and the vertical rise 52 ft. (*Meydum* iii). The main causeway of Khufu at Gizeh, slanting up the cliff face, was built of enormous blocks. That of Khafra was cut in the rock along a ridge, and afterwards closed at the end by the granite temple. The long causeways of the pyramids of Abusir, Saqqara and Dahshur are obvious on the ground, and may be seen in all the plans. The causeway of Khufu was reported, in later times, to have taken ten years to construct, along with the needful rock excavation for the pyramid. Herodotos describes it as 60 ft. wide, 48 ft. high in parts, and 300 ft. long. As the pyramid of Khufu contains over four times the amount of material of that at Meydum, and occupied very little longer to build (20 years instead of 17), there must have been about 15 or 20 lines of transport. The causeway 60 ft. wide would take nearly as much as the whole Meydum traffic, but it cannot have carried more than a quarter of what was needed for the whole of the pyramid of Khufu. Another causeway is seen toward the south. Probably the Khafra causeway was originally made by Khufu to supply the western side of his pyramid, and other tracks may have existed parallel to that.

32. Handling. The practical shifting of blocks in detail was doubtless done by levers. On the granite blocks of the pyramid of Khufu, where not finally polished, there may be seen a projecting boss of stone, about 5 ins. wide and an inch or two thick; and on the polished blocks of the King's Chamber the positions of two larger bosses, dressed off on each face, may be seen by slanting light (57–58). Such bosses are also seen on finished work in granite and limestone, as at the ends of sarcophagus lids (*Meydum*, x, 4). Other large blocks of rough limestone have a recess cut in the base edge, often about 5 ins. wide, 5 high, and 2 deep. These bosses and

recesses are evidently to give a lifting point for a lever or crowbar.

Models of crowbars (59) with bent ends, made of copper, were placed in the foundation deposits of tools under the xixth dynasty temples of Ta-usert and Siptah. The thick snub end of the first is well designed.

For small shifting of blocks, there appears to have been used a large lever horizontally rotating on its fulcrum. The blocks of limestone with deeply scored cavities in them, caused by rotation of an irregular knob under very heavy pressure, are commonly found in builders' rubbish at Meydum (60). They were used and re-used, until there was no clear place left on either side, and often they had broken up by the pressure. These have commonly been used for a vertical pivot, as the blocks have no sort of regular form, and fit any position as horizontal bearings. The only instrument that seems likely is a long wooden lever, with a peg beneath it as a fulcrum. After taking a lift with it, under a boss or in a hollow of a stone, the lever was then turned on its fulcrum, and so drew forward the stone. Thus by turning the tail of the lever round two or three feet, the stone would be moved forward a few inches. This is the most effective way for a few men to move a large block which is beyond their direct powers, as I know practically in Egypt. After one lift and drag, the fulcrum was shifted forward, and the lever set on it for another lift. Metals being valuable, probably all crowbars then used were beams of the hard *sont* or acacia.

33. Raising. The simplest of all ways of raising great weights is by ramming sand under them. Two Arabs contracted to take a colossal sarcophagus out of a deep pit. A short stick was their only apparatus. One man rammed sand hard under the sarcophagus, regularly working round it, the other threw down more sand as it was used. In a few weeks the great mass stood on the top of the well, which was now full of sand. For some

purposes, where time was no object, the ancients may have worked similarly ; but great royal works were a busy scene crowded with as many men as could reach the work, and every hour was important.

The easiest method of raising long beams of stone was by tilting up. If a beam is supported on two piles near the middle of it, a moderate lift will raise it from one pile or the other. If the piles be a tenth of the length of the beam apart, say 18 ins. on a 15 ft. beam, only $\frac{1}{10}$ of the weight has to be lifted at one end (60). A gang of men which can stand on half a beam, walking up to the higher end alternately, would suffice to lift a beam of granite 9 ins. deep, if the supports were a tenth of the length apart. Or for an obelisk 7 ft. square, men standing 18 ins. apart over half of it, would require the supports to be 20 ins. apart under a 100 ft. obelisk. If the obelisk tilted 5 ft. up and the same down at the ends, when rocked, the slope would be 1 in 10 and the pile from which it rose would have 2 ins. clear over it, to place a fresh support upon, so as to raise it. Thus the obelisk would rise 2 ins. at each tilt. As the 160 men on it might take a minute to walk 50 ft. in close pack, from one half to the other half of the obelisk, the main part of the time would be taken in adding and adjusting the supports. Perhaps five minutes for one lift might be required, lifting the whole, therefore, 2 ft. in an hour, or 20 ft. a day. I have actually used tilting, to raise a column up a stairway.

The granite beams, averaging 55 tons, of the roofs over the king's chamber of Khufu's pyramid would require supports 7 ins. apart, to tilt when one half was loaded with men. If the ends tilted up and down 3 ft. on 13 ft. of half length, that would give $1\frac{1}{2}$ ins. clear for adding to one support at each tilt. The support must not be less than 11 square ins. of granite or it would crush down.

The main trouble comes not in actually lifting the

weight, but in securing it. The elasticity, or crushing, or wobbling, of the supports may easily take up all the gain. It is necessary to have blocks of the hardest stones to form the supports, if narrow. A large obelisk would need granite bearings of at least half a square foot, to save them from crushing with the weight.

34. Cradles. In the xviiith dynasty, models of a simple form of cradle were often buried in foundation deposits. The use of these to give shifting support to blocks of stone is obvious; but the details that have been suggested, as by Choisy, are impracticable. In order to give effective help in raising the centre of gravity of a block, the centre must be not too far below the centre of curvature of the cradle (62). A block wider than its height could scarcely be rocked at all; it requires the block to be on its end, nearly twice as high as it is wide, for the cradle to rock effectively. No form of lever applied to the cradle bars would act, as it would smash the cradle by its leverage. Pushing the block over, and perhaps pulling it also by a rope, would be the effective mode of rocking. The practical adoption of such a form therefore requires us to picture the use of it in these proportions. Rocking it first from one side and then to the other, wedges of wood could be put beneath it, and so the mass steadily raised until shifted on to a higher step of building.

Stepping up. For any raising of blocks, a thoroughly firm stage was needed. This was sometimes on the lower levels of the masonry, from which a block could be raised to a higher course. In great work, however, such petty methods would be quite impossible, and earth slopes were necessary.

35. Earth Banks. For the hundreds of blocks needed daily in building a pyramid, the only practicable method would be dragging blocks up a long slope, such as we see was provided below the Meydum pyramid.

The earth bank needed for this would be held in place by brick walls through the mass. Such walls are seen in the remains of the earth banks at the great pylon of Karnak (63); and similarly at the quarry of Qau a long earth slope was held up by a thick brick wall. The staging at Karnak extended to near the top, as there are rows of rafter holes high up in the stone face, for a shed.

A scheme of work to cover all the requisites of a pyramid has been suggested (*Anc. Eg.* 1930, 33). This involves a great earth bank the width of one face, up to about 400 ft. high. The blocks would be dragged up in parallel tracks. The exactitude of the casing, already cut to the angle, would be provided by laying the case of a course first in place, sighted down the three empty sides to the base. Then the core blocks would be brought in and packed behind the course of casing. The embanked side would be finished last, sighted from corner to corner, before proceeding with the next course. The top hundred feet, less than a hundredth of the pyramid, would have to be raised by staging on the courses. As a single statue had a slope a third of a mile long for raising it (figs. 65–67), there is no difficulty in believing that a vast bank was used for a pyramid.

36. Earth Filling. Not only was earth used outside a building but, from remains of brick walling and earth in the Great Hall of Karnak, it appears that the hypostyle halls were filled up solid with earth, as the work progressed, in order to give a firm ground for moving each course into place. The walls being built first, the measurements could be taken off for each layer of drums of the columns, so that there was no risk of getting them irregular owing to the lower part being invisible. The blocks were all built in with a surplus on the faces (64), so that an inch or two could be removed in the final dressing. The dressing probably took place while the earth was being removed. This system of solid filling is quite

practicable, and was used by M. Legrain in making the restorations of the Great Hall, at no more cost than tackle, and with much more safety when in the charge of unskilled men.

37. Erection of Monoliths. This work demands more skill and enterprise than any other form of transport, and it has always been looked on as a crowning triumph of mechanics. In classical or papal Rome, in Paris or London, such labours have always caused the greatest interest. Happily we have a measured record of the arrangements for the erection of colossi of Rameses IV, which explains much of the system (see figs. 65–67). A causeway of earth was made, of 730 cubits long, 55 wide at the top, and 60 high on the slope. The sides were held up by 120 frames of beams and brushwood, some of 30 × 7 cubits. (*Stud. Hist.* III, 169). The direct height is not given but, as the slant height is stated as 60 cubits, probably the proportions of the slope had a multiple of 3 or 5 in the diagonal. As facings were used to keep the earth from crumbling, the angle must have been steep enough to need them, and not merely the angle of rest. From practical examples of piling up a bank of damp earth and mud, in Egypt, 42° is the average, and 45° the steepest slope, without any retaining cover. Now as the Egyptian reckoned profiles in terms of rise and base, the question is what simple proportions would be near this? A rise of 4 on 4½ base has 6 diagonal, angle 41° 38′; 1 on 1 base is of course 45°; and the converse, of 4½ on 4 with 6 diagonal, is 48° 22′. The facings suggest that the higher angle was used, but if the earth were crumbly and not moist, it might be the lower. If we take 45° it can hardly be far wrong. That would mean 42½ cubits base and height for 60 slope (17 to 24 for diagonal ratio = 1·411). Hence the bases of the two slopes would be 85, and as the top width was 55 cubits, the whole base was 140 cubits. The slope of 60 cubits was faced by two rows

of frames 30 cubits high. This much is pretty closely defined by the Egyptian account.

When we come to draw this to scale, we see that the slope up was 1 on 17, the causeway being about a quarter of a mile long. By hauling the colossus up this, it was raised 42½ cubits or 73 ft. The size of the colossi is not stated, nor is there any trace of a colossus of this king by which we could judge. From the height to which it was raised it must have been large and, if we take the usual size of pylon colossi at Karnak, it might be about 24 cubits high or 41 ft. The cross section of the bank shews that there was abundant strength, and room for the trains of men hauling the colossus along.

What happened when it reached the head of the causeway, we can best judge by looking at the section. It would begin to crush down the edge of the bank when hauled as far as might be (A). The centre of gravity of the block is marked by a spot, so that the movement can be traced. Holding back the block from sliding, by ropes passed round the toes and fastened back to the causeway, the men would dig out the earth below the feet of the block. Such earth compressed by piling can be dug away vertical before it caves in. After cutting a pit in the end of the bank, the colossus could be liberated, and would slip down into the pit in position (B). By carving away the earth beneath it, and ramming earth in behind the head, it would be slipped down into position (C). There, by scraping out the earth, it could be slipped on to the pedestal. By thus keeping the block held up by earth, it could be dealt with gradually and precisely by cutting out earth on one side or another, to keep it from falling over or tilting sideways. The amount of fall or slip allowed would regulate how much it moved forward, and so adjust it to its base.

The final settlement of a great mass on a clean surface of base has not been satisfactorily explained. The proposal

of Choisy that bags of sand were used is quite impossible, as sand will not run except from a face steeper than the angle of rest. The long bags, which he mentions, could never be emptied when a great weight was resting on them. To scrape out the sand would be impossible, as the colossus would tip over on to the scraper. The actual instance known, of lowering a sarcophagus lid by resting it on pits of sand, depends only on sand running out of the bottom of a cavity. Practically, it seems most likely that the colossus, when nearly down, was held by shores of timber while the pedestal was swept clear ; and then, by pecking out the earth under the shores and letting them sink evenly, the block could be let down a few inches into place.

We see thus that in any case the main principle was to bank up with earth, as in the building of hypostyle halls ; and the matter of handling great masses in such an instance is safe and practicable, whatever may have been the minor details.

The Egyptians probably used simple means, rather than elaborate mechanics, for obelisks. The suggestion of Choisy is quite impossible, in view of Egyptian material and methods. To swing an obelisk on trunnions, as we did with that in London, needs a great amount of metal girders and bands. We cannot suppose that about 10 or 15 tons of bronze were made up into a bed and trunnions, by which to swing the obelisk upright. Nothing less than $\frac{1}{20}$ of the weight of the obelisk could suffice, as the bronze clutch bed had to hold the weight hanging from the trunnions as it came upright. Nothing but metal could hold up 300 tons by a butt grip. The mere tensile strength of the bed would need 5 tons of metal, to say nothing of the double bands needed under the foot, and the great cross strength of the trunnions. We need not consider a method which was impossible, so far as we know the materials and methods of that time.

The earth banking which was certainly used for colossi would also be applicable for obelisks. There would be no difficulty in getting an obelisk up to 45° by tilting over the head of a bank. The base would then be protected by planks and matting to keep the pedestal clear ; the earth bank would be advanced on either side to hold the obelisk from skewing, and ramming earth in hard behind it would gradually push it forward. Thus it might be steadily advanced toward the upright. The great obelisk of Hatshepsut would at 70° require a pull of 40 tons at the top to bring it upright ; at 80° it would need a pull of 11 tons ; and at $84\frac{1}{2}$° it would settle into place by itself. As a 6-inch hawser holds about 3 tons, so 4 hawsers would pull it up from 80° or 13 hawsers from 70°. Probably it was brought up by ramming earth, to about 1 in 4, or 76°, and then 8 hawsers, with about 800 men pulling, would suffice to bring it to the vertical. Such seems to be the practical method of utilising the usual Egyptian resources and methods without running any risks, even in handling the largest masses. A more fool-proof method is proposed by Engelbach (*The Problem of the Obelisks*), having a pit of sand on to which the obelisk tips endways, and then sinks into position as the sand is removed. The difficulty of removing all the sand while the obelisk is pressing down, however, seems greater than the difficulty of dealing with stiff clayey earth or brick wall, which can be cut vertical under pressure.

CHAPTER V

STONE CONSTRUCTION

38. Foundations. The early monuments are founded on rock where possible, as at Meydum and Gizeh. The rock bed was dressed to an exquisitely true level at Khufu's pyramid, though left with rough face in order to hold mortar.

Where rock was not accessible, the stones were placed upon a bed of sand. The sand used was in all ages the cleanest that could be got: at Sneferu's pyramid it was washed so as to be uniformly coarse clear-grained grit, in later times it is clean washed yellow sand, and only in the most careless work is it common sand. The depth of the sand varies from an inch or two, to as much as 12½ ft. where it was desired to reach through a mass of brick ruins. So customary did this sand bed become, that by the xixth dynasty trenches were cut in the rock, and filled in with sand on which the walls were laid, as in the funerary temples at Thebes. The importance attached to the sand bed was such that at Koptos the Ptolemaic builders had sand brought from two miles distant; and it was used to such an amount that it would have occupied a train of 100 asses for half a year's hard work to bring it in. These sand beds are of the greatest importance in tracing the positions of destroyed buildings: often it is possible to restore completely the outline of a building of which not one stone remains, by means of tracking the few inches of sand on which the masonry had rested. Further, the foundation deposits put into the sand generally give the date of the building.

The purpose of a sand foundation was obviously to give a dry basis on soil of slippery mud, and to allow of soil expansion without fissuring the buildings. It must have been adopted first for building on the Nile plain, though afterwards used upon the desert. The facility of adjusting the first course to a true level, by sinking the blocks more or less in the sand, doubtless brought it into favour. This would be specially so, as the foundations were generally of untrimmed blocks, which extended beyond on each side, and only the top face was dressed.

In some cases, strange to say, mud bricks were put beneath stone as foundations, as at the pillars of the Ramesseum (according to Choisy) and in some Nubian temples.

The depth of foundations varies much. In most instances it is of two or three courses; it may be only a single course as at Ehnasya; or may be 8 ft. deep as at the temple of Tehutmes III at Koptos; or 10 courses, 16 ft. deep, as at Athribis.

Sometimes the foundation was much wider externally than the wall, and there was a sloped footing originally to keep rain from dropping on the foot of the wall (*Kahūn* fig. 6). This is seen in the basalt footing and wall of Ramessu II at Memphis (7) (*Memphis* I, xxi), and the front of the tower at Medinet Habu of Ramessu III. There is no regular feature of steps or stylobate.

39. Wall Building. In early times, as in the pyramid of Khufu, it was a principle to adjust each course to a level top by sinking the irregularities of thickness into hollows cut in the course below. In outer faces, however, the course lines were kept regular. The core masonry of the pyramids is rough, no attempt being made to keep to close joints, and the stones were regarded more as props for the upper part than as forming a continuous structure.

Lines were drawn on the wide foundations to define

the place of the coming building (see *Ehnasya*, x, and *Athribis*, xxxv). Such lines were the real setting out of the building, the foundation course being only laid approximately.

Dovetails or cramps were usual in stone work. At the granite temple of Khafra the architraves were secured to the pillars by copper plugs, but every joint has been broken away by plunderers to extract the metal. This is like the hewing of holes at every joint of the Colosseum to extract the metal cramps, so that these buildings are much weaker now than if no metal had been used.

There were no cramps found in the gateways of Pepy, nor the work of Senusert or Amenhetep I at Abydos, and it is doubtful if ever cramps were much used in limestone work. On the other hand, the sandstone buildings of the xviiith and later dynasties may be seen to have every block of walls and roofs cramped to the next (*T.K.* xxiv). The material of these cramps is usually ebony or *sont* acacia, sometimes black granite and, it is said, bronze. They often bear the names of the builder, especially of Sety I.

In the pyramid of Sneferu the stone blocks are twice as long as they are wide, like bricks ; and they are laid with a course of headers and course of stretchers as in the usual brick bonding.

The system of building the two faces of a wall without any cross bond seems inexplicable to us. The blocks seem to have been simply regarded as piled supports, and the breadth of each stone sufficiently secured its stability upon the lower part. Thus when a temple was being destroyed, it was possible for a whole face of a wall to be removed, leaving the other face and its roof complete. This is seen at the Ramesseum, where the battle of Kedesh is figured on the remaining face of a wall.

This method led to filling in with rubble between two

faces, as may be seen in the Sety temple at Abydos (*Temple of Kings*, xxiv). Still worse is the very unsound plan of building a pylon as a mere shell, and filling it with rubble as in the burst pylon, Karnak (68).

The mortaring in the pyramid of Khufu is very coarse in the core masonry, mere lumps of brown marl paste to choke the hollows, but where it was important it is of the finest. The walls of the chambers are mortared with such fine joints that they can scarcely be traced. On the outer casing, joints with a length of 6 ft. have an average width of only $\frac{1}{50}$ in., and the mortar extends over the whole joint face of 35 sq. ft. Certainly the stones must have been wet to enable it to run in ; even so, the setting of such large masses with such close joints at sides and base is beyond our experience.

40. Wall Dressing. The ideal in early times seems to have been copied from rock cutting. An artificial rock of blocks was piled together, leaving rough hollows where passages and chambers were intended. Then the masons dressed down the surfaces just as they were already accustomed to dress rock faces. The proof of this may be seen by the blocks all running round the inner corners a few inches (69), showing the amount which had been dressed off the faces after building. This system appears in the pyramid times as at the limestone temple of Sneferu, the granite temple of Khafra, and in the mastabas, for instance Gemni-kai ; in the xviiith dynasty, the temple of Tehutmes III at Karnak ; in the xixth dyn. temple of Sety at Abydos ; in the xxth dynasty at Medinet Habu ; while the wall may be seen still in the rough in part of Kalabsheh, and with the first drafts cut across it, to define the face, at the kiosk of Trajan on Philae.

The same method of building in the rough for columns appears at the Great Hall of Karnak, where the great columns, of the part engaged in the vestibule wall, still have the excess left on the faces of the blocks (fig. 64) ;

the dressing was stopped when the builders determined to insert the vestibule, and this reveals the curious fact that the detailed sculpture was carried out on each block as soon as its face was dressed, without waiting to trim the next block.

The method of cutting down to a true face was thoroughly correct (W.*M.C.* 430). Straight lines were drafted along the edges of the face, very generally by making a saw-cut, about half an inch to an inch into the stone. Then, the face being horizontal, two offset pieces A B, about 4 ins. long, were held upright on the drafts, with a string stretched from top to top (70). Another offset piece C, of the same length, was placed on the stone face, and the excess of the stone read off on the stick against the string. The stone was then reduced by adze or by chisel until the excess was removed all over, testing it continually by the piece C (P.*T.W.* lxxix). The set of three offset pieces was found (*Kahūn*, ix, 18) with the string, and stray pieces have often been found elsewhere.

For large faces it was needful to take special measures, to avoid a twist or wind in the face. For this, diagonal drafts were necessary, to lie in one plane, and the string was stretched diagonally (P.*T.W.* lxxix). Such a diagonal draft can be seen, still shewing, on the great block of granite over the entrance to the king's chamber in Khufu's pyramid.

The face having been generally brought to a flat plane, the dressing of it smooth was tested by a true facing-plate smeared with red ochre. Wherever the ochre touched the face, the stone was slightly trimmed with the adze, the strokes crossing in all directions. As soon as the red ochre touched on spots not over an inch apart all over the face, it was considered finished for joint faces : and it was in state for grinding or scraping down to produce smooth faces. The red ochre spots are visible on every projection

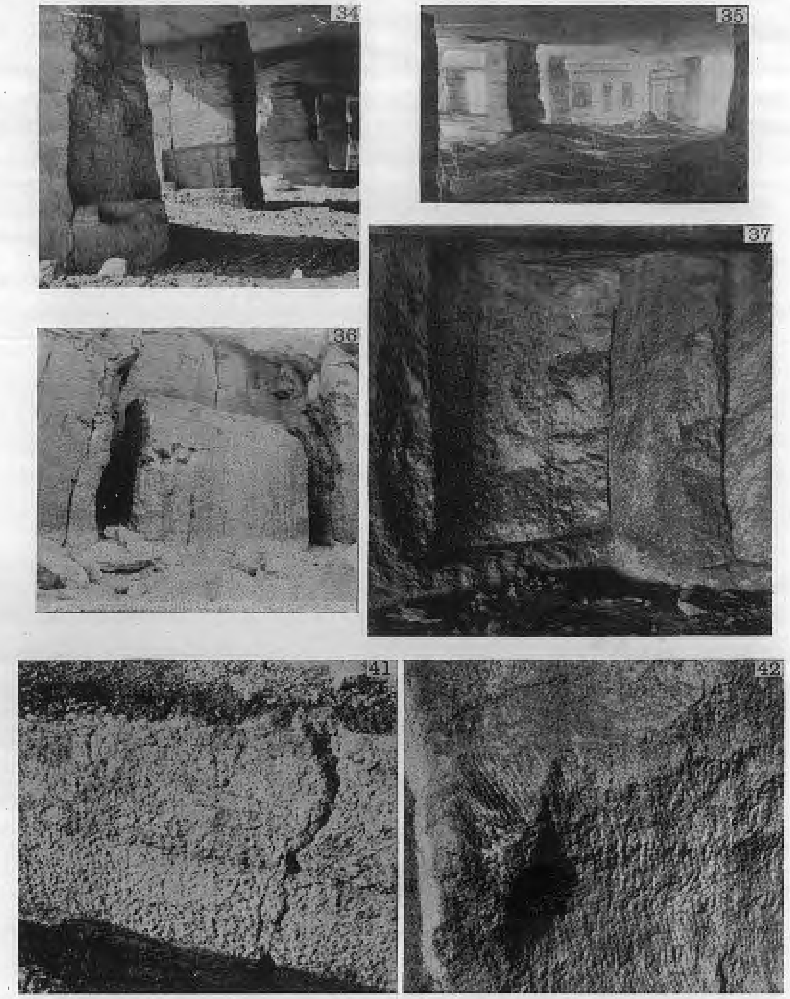
in the dressed faces both of masonry and of rock in the great pyramid work.

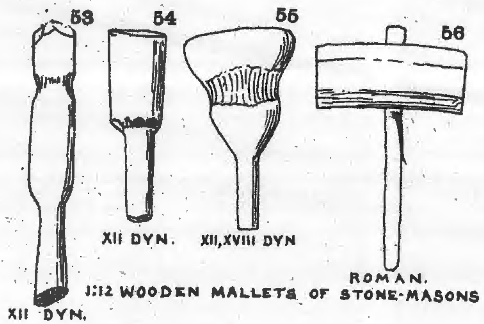
41. Roofing. The system for roofing was to place architrave beams from column to column, and rest the roof slabs upon these. For great spans, where the weight of the beams was awkward to handle, two narrow beams were used side by side, as on the largest columns of the Great Hall of Karnak, and of the Ramesseum. This did not sacrifice any strength. It was also the system at the Parthenon. The roof slabs were roughly dressed on the upper surface. Usually a shallow groove was sunk in two slabs along their joint, apparently to hold a stopping of mortar to prevent wet penetrating. Sometimes the edges are raised, so as to prevent any water running off the stone into the joint.

42. Irregularities. In some instances, irregular fitting of courses may be seen, notched in small steps up and down. A dressed stone wall is never found of polygonal blocks, or without horizontal joints ; the irregularities are limited to small shifts of the joint in rare instances. The courses may vary in height, as in the pyramid of Khufu, where no two are alike. Groups of courses start thick, and each successive course is thinner until the smallest is reached, above which a fresh start of thick courses appears. This must be due to laying out a large field of blocks at the quarry, and picking over from the thickest down to the thinnest ; after which a fresh quarry field was used. Yet the fresh start is made at the definite break of horizontal area (see *Anc. Eg.* 1925, 37). In fine work, however, as the granite of the chamber of Khufu, the average variation on courses four feet high is 0·056 inch, throughout a run of 515 ft. length of blocks.

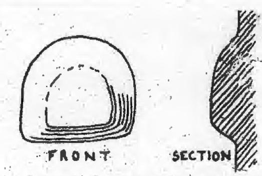
Patching of defects in granite was done with plaster, and coloured ; a large patch remains at the top of the chamber of Khufu. In limestone, pieces were let in where stone was defective or broken. The casing of

Teta's pyramid was badly handled, and the acute edges were often damaged ; these were largely patched by insertions. Similar patching is seen on the south pyramid of Dahshur. Bad places in rock cutting were filled with cement which has lasted much better than the rock, as in tombs at Gizeh ; or pieces of stone were inserted, as at Tell el Amarna.

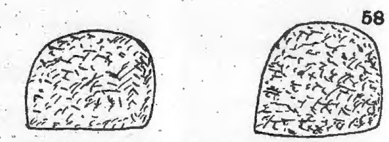




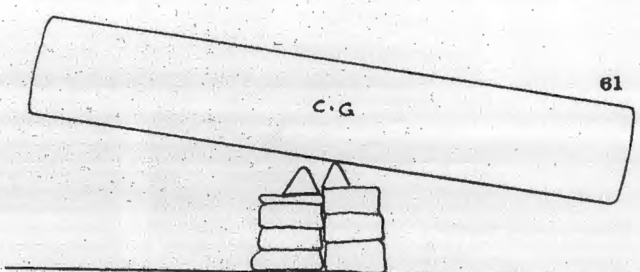
1:12 WOODEN MALLETS OF STONE-MASONS



BOSS ON GRANITE FOR LEVER BEARING

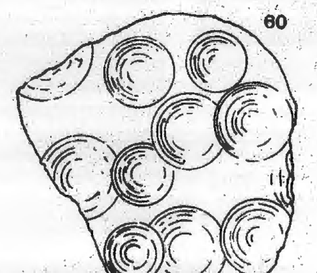


BOSSES DRESSED AWAY FROM GRANITE BLOCK

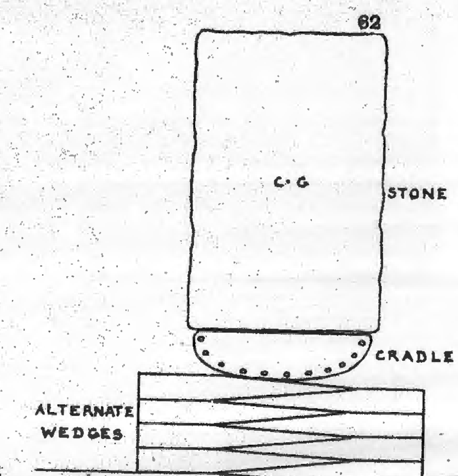


1:100 LARGEST GRANITE BEAM OF KHUFU RAISED BY ROCKING ON ALTERNATELY RAISED SUPPORTS. IV DYN.

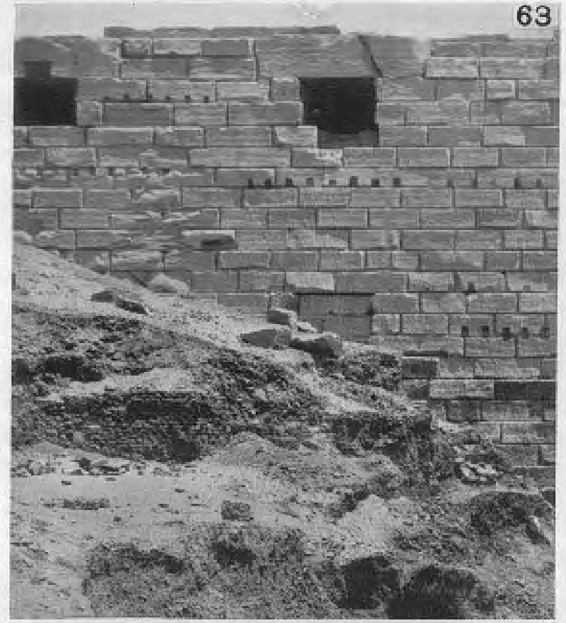
BRONZE MODELS OF CROWBARS SIPTAH, XIX DYN.



1:10 FULCRUM BLOCK OF PIVOTTING LEVER MEYDUM III DYN.



ROCKING UP STONE ON A CRADLE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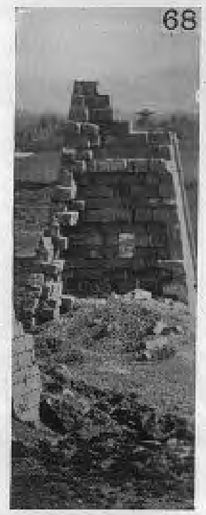
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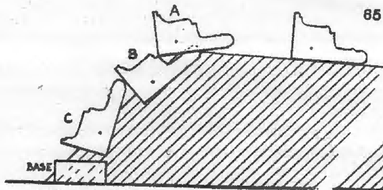
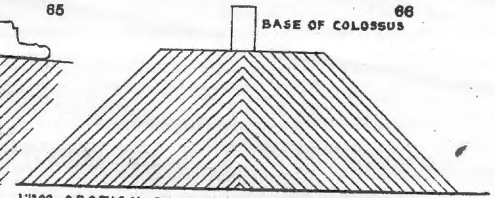
STONE RAISING, DRESSING ; FLUTED COLUMNS XII

65



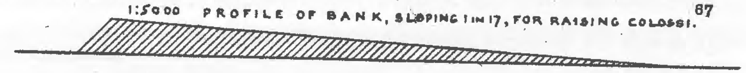
1:200 SUCCESSIVE POSITIONS, A, B, C. IN LOWERING COLOSSUS FROM BANK AND ERECTING IT ON THE BASE.

66



1:200 SECTION OF HIGH END OF SLOPING BANK.

1:5000 PROFILE OF BANK, SLOPING 1 IN 17, FOR RAISING COLOSSI. 67



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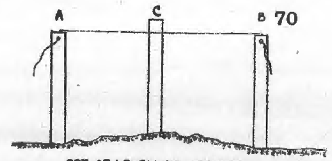
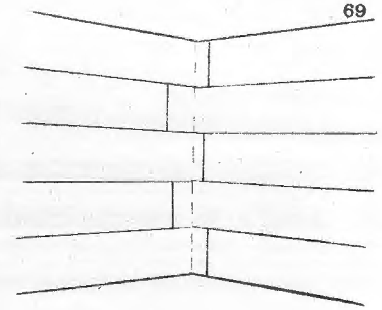


SET OF LEVELLING OFFSETS.

69



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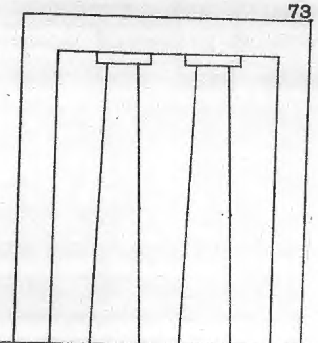
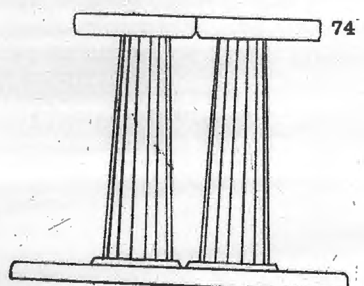


PORTICO WITH TWO COLUMNS III DYN.
HIEROGLYPH, TOMB OF METHEN. L.D.II.VI.

71

74



WOODEN HEAD-REST WITH FLUTED COLUMNS:
FLUTING OF RELIEF RIDGES. TARKHAN, III DYN.

76

COLUMN WITH HOLLOW FLUTING
RED, BLACK BELOW
HIEROGLYPH, MEDUM. III DYN.

CHAPTER VI

FORMS OF SUPPORT

43. Torus. Besides the surface treatment of the wall, which we have already noticed, there was another characteristic feature, the torus roll down the outer edges of buildings, particularly on the edges of pylons and façades. This appears first in what are clearly structures of reeds, maize, or palm-sticks; where the detail is shown on a larger scale, it always has a line of binding around the torus. Until the Ptolemaic age, the torus under the cornice, and down the edges of the building, is lashed around, and the line of binding carried diagonally on to the following lashing (71). The combination of this roll with the sloping faces derived from brickwork may seem incongruous; but it may arise from corners of a brick building having a fender of maize stems at the edges to save them from damage by passing burdens. In Palestine, blocks of stone are put at the danger point in brick corners.

44. Pillar. The simplest form of support is the square pillar, mainly found in rock-cut chambers, or those early structures which were imitated from rock-cutting. It was usually equal-sided, but some oblong pillars occur in the Granite Temple of Khafra (72). The square pillar never has a capital or abacus, nor is it diminished upward until the xviiith dynasty. It was only when the polygonal imitations of wooden columns set the standard of taste, that the square rock-pillar lost its simplicity.

The height and interspace of pillars of various age

differ considerably. For comparison, it is best to reduce all dimensions to the unit of the greatest diameter, the recognised modulus. This will be called here 100 in all tables of proportions, to avoid decimal points. The height of the pillar, the interspace between the faces, and the top width when it tapers, are here stated. L.D. refers to Lepsius, *Denkmäler*; W.A. to Wilkinson's *Architecture* (measured from drawings); Ph. to measurements from photographs, some of which were taken on purpose for this, so as to show a complete example, free from obstructions; measurements are made at the sides of the pillars, in order to be comparable with the diameter.

Dyn.	Pillars		Height	Inter-space	Top Width	Material
iv	Gizeh, granite temple		444	210 / 254		G
iv	Saqqara . . .	L.D.I, 42	390	261		L
v	Saqqara . . .	L.D.I, 39	560	258 / 295		L
vi	Zowyet El Mayitin .	L.D.I, 57	295	174 to 200		L
xviii	Speos Artemidos . .	Phot.	470 ?	150		L
xviii	Deir el Bahri, lower .	Ph.	485	148		L
xviii	Deir el Bahri, upper .	Ph.	480	189 to 200	86	L
xviii	Karnak, Tehutmes III .	W.A.	400	186	94	L ?
xviii	Karnak, Tehutmes III .		384	154 / 167	97	L ?
xviii	Karnak, Tehutmes III granite	Ph.	605			G
xviii	Medinet Habu, Tehutmes III	Ph	392	160		S
xviii	Karnak, Amenhetep II .	L.D.	—	181		
xviii	Karnak, Amenhetep II .	W.A.	420	169	89	
xviii	Karnak, Amenhetep III.	Prisse	317			
xix	Abydos, Sety I . . .	Ph.	360	168		L ?
xix	Qurneh, Sety I . .	L.D.I, 86	450	278 entr. / 145		S
xix	Tomb of Sety I . .	L.D.I, 96	299 to 319	156 to 188		L
xix	Redesieh, Sety I . .	L.D.	360	212		L
xix	Derr, Ramessu II . .	W.A.	261	132	87	S
xix	Ramesseum, Ramessu II.	Ph.	410	79 to 87	86	S
xx	M. Habu, Ramessu III .	Ph.	360	105 to 161	97	S

G granite, L limestone, S sandstone.

The purpose of these variations is largely to agree with the nature of the material. Setting aside the rock cutting, the height of sandstone is 369 (261–410), of limestone 455 (390–560), of granite 444 and 605.

The same difference is seen in the interspace; in sandstone it is 150 (83–212), in limestone 210 (148–276). The weaker sandstone requires the columns to be thicker, and the space less, beside necessitating shorter architraves.

The rock cutting in limestone is more massive than the built forms. The pillars are only 300 in height, with 167 interspace, in place of 455 and 210. This was in order to save labour in excavating the chamber.

The diminution of the diameter toward the top varies, in different instances, from 86 to 97. The purpose of this was to diminish the load on the base, by reducing the area in proportion to the load it had to bear. Taking eight instances of columns where the total load can be traced in publications or photographs, the load at the top of a column is between 0·37 and 0·83 of the load at the base; requiring therefore a diminution to between 0·61 and 0·92 of the main diameter. The diminution is never so much as the decrease in weight would justify; the lower part remains the weakest part of the column, but that was due to a desire to avoid bulk below and leave freer space around it.

45. POLYGONAL COLUMN. Here a new motive appears in the abacus. This has no meaning in stonework, as it only adds a load, and one liable to crack from its thinness. But in woodwork some bonding is needed to carry the ends of the architraves, and prevent them bearing unequally on the tree trunk. Still more is an abacus needful for a column of stalks or reeds bound together. Hence all columns with abaci show their origin in organic prototypes (73). The examples of polygonal columns are here stated, with the lower diameter taken as 100.

Dyn.		Sides		Shaft High	Abacus High	Abacus Wide	Top Wide	Inter-space
iii	Meydum hieroglyph .	16		413	—	—	70	—
iii	Zeser colonnade . .	16	Ph.	—	—	—	—	170
iv	Methen hieroglyph (73) .	?		580	—	—	—	90
xii	Benihasan, Ameny . .	8		525	21	100	—	181
xii	Benihasan, Ameny . .	16		482	19	96	92	294
xii	Benihasan, Khnumhetep II			600	—	—	—	240
xviii	Deir el Bahri, Hatshepsut .	8	Ph.	550	38	85	85	188
xviii	Karnak, Tehutmes III .		Ph.	560*	40	95	95	192
xviii	Medinet Habu, Tehutmes III	16	Ph.	537	52	104	95	—
xviii	Semneh, Tehutmes III .		W.A.	378	22	97	—	275
xviii	Kummeh, Tehutmes III .		L.D.	—	—	—	—	342
xviii	El Kab, Amenhetep III .			398	24	92	—	290
xviii	Ivory model kohl-tube .			461	49	100	100	—
xix	Beit el Waly, Ramessu II .		W.A.	216	25	85	—	—

The FLUTED COLUMN appears early in the 1st dynasty (*R.T. II*, xxxiv, 73), and was usual in the iiird (74) with an abacus. Both the hollow fluting and the solid fluting were used by Zeser (iiird dyn.) (75). In the later architecture, the polygonal column has the four cardinal faces flat (sometimes inscribed), while the other sides are hollowed. In all instances the hollowing is only about a tenth of the width, or less, differing from the deeper hollowing of the Doric, or still more the Ionic.

The columns were coloured black below and red above (76), iiird dyn., or black below and white above, xiith dyn. Some closely fluted, engaged columns, were all red, with green abaci (xii, Labyrinth). For the essentially important architecture of Zeser at Saqqara, the carefully justified restorations by M. Lauer are copied here, by permission. I am indebted for the Zeser illustrations, 77, 78, also 84, 86, to the official publications.

The proportions at Saqqara (Zeser, iiird dyn.) (77) are, max. diam. 1·0, interspace 2·19, height 5·29, abacus 0·38. In the very slender Hat-hor columns (78), these dimensions are 1·0, taper to 0·56, interspace 5·2, height 17·8, all engaged columns.

46. TENT POLE. A strange type was evolved from the great tent pole, such as is shown in the centre of the vizier's audience tent, which is the hieroglyph (79). This pole (80) became copied, after a long interval, by Tehutmes III at Karnak (81). The proportions of these are :—

height, shaft 429, capital 127, abacus 39, architrave 71
width, base 100, near capital 108, capital 126, abacus 94, interspace 211.

47. PALM. This is one of the finest forms of capital used, and the least corrupted in copying. The grand columns of the vth dynasty temples are monoliths of granite over twenty feet high (82). The shaft never has any structural detail, but a conical taper without entasis. From the earliest to the latest example, there are nine branches around the head. The bands below the branches are five, an exception is six at Kom Ombo. On the front of the column is a loop below the bands, which was faithfully copied from the vth dynasty down to the Ptolemies. The branches are distinctly an applied ornament, quite independent of the bearing parts.

At Amarna the capital had coloured glazes inserted along the leaf lines, and enclosed in gilt setting (P., *Amarna*, vi). In the xxist dyn. the tops of the branches were exaggerated, hanging down (83). In the xxvith dyn. the older type was revived, with the tips slightly more upright (*Palace of Apries*, xii). The secret of the grace of the early examples lies in the faint gathering in of the outline of the capital above the band, so that there is a continuous curve to the tip : in late times the lower part of the body is quite straight.

The taper of the shaft varies from $\frac{1}{6}$ to $\frac{1}{12}$, but in terms of the height it is less variable, as 1 in 31 to 1 in 42. It seems therefore that the taper was more regulated by the height, or as a slope of 41′ to 56′ up the side. The interspace is far less than it is with pillars or polygonal columns : this is probably because this form was mainly used in façades, where the wide space would seem weak. The form was often copied in glass, during the xviiith dynasty, for kohl-tubes.

			Height			Width				
Dyn.			Shaft	Cap.	Abacus	Top Shaft	Cap.	Abacus	Bands	Inter-space
iv	Throne of Khafra	Ph.	670	310	56	—	280	310	—	—
v	Sahura . .		500	149	32	88	125	80	35	—
v	Ne-user-ra .		501	150	31	88	—	—	35	—
v	Unas . .	Ph.	578	187	35?	85	160	100	49	—
xii	El Bersheh (pl. iv)		457	126	14	83	142	91	32	—
xii	Kahun, ivory model		—	158	—	85?	153	—	—	—
xii?	Ehnasya . .		526	140	36	85	140	102	37	162
xii?	Bubastis . .		486	144	35	88	142	104	—	—
xviii	Soleb, Amenhetep II	L.D.	384	104	33	91	156	84	39	{107 122
xxvi	Memphis, Apries	Ph.	—	130	—	92	150	—	41	—
Ptol.	Kom Ombo .	Ph.	418	132	31	92	148	88	45	115
Ptol.	Edfu . .	Ph.	432	119	30	89	150	89	34	111
Ptol.	Philae . .	Ph.	465	131	51	85	130	83	39	157
Ptol.	Philae . .	W.A.	430	121	29	88	151	83	35	144
Ptol.	Philae . .	W.A.	400	119	50	83	144	75	40	—

The proportions in the various periods are tolerably consistent. The first example is a relief of a *sma* emblem on the throne of Khafra, so it must not be accepted as of structural proportions.

48. RUSH BUNDLE. The so-called *dad* or *zed* column is explained by the examples in the iiird dynasty at Saqqara (84). The column appears a bundle of papyrus stems, with four bands around, and a quadruple tie below the spreading head, sometimes coloured alternately (85). This seems to us to resemble a bundle of rushes or papyrus stems, tied near the top, and doubtless plastered with mud to keep them stiff. Such bundles of stems are commonly used now to support shadūfs. Formerly it was a favourite form for furniture, and for window bars, but was not used in stone architecture.

The origin of this group may be four separate columns. These would refer doubtless to the four supports of heaven, for the group was the emblem of stability.

49. PAPYRUS. There has been confusion between papyrus and lotus forms, which are often combined. The essential facts are :—

1. The Egyptian lotus stem is a flexible form, which

cannot hold itself upright; it only floats in the water. It cannot form a column.

2. The papyrus stem is stiff, and was used largely in construction, when tied up in bundles.

3. The papyrus head is a mass of loose filaments, copied in expanded form in the iiird dynasty.

4. The unexpanded form was copied in the vth dynasty.

5. Lotus petals were, in the vth dynasty, added to the unopened papyrus column, converting it into a group of lotus buds.

6. The blue lotus is generally copied, but the short and thick white lotus (with red inside) also appears.

We shall have separate classes thus :—

A. Clustered papyrus with open head (iiird dyn.)
B. ,, ,, unopened head (vth dyn.)
C. ,, ,, degraded smooth (xixth dyn.)
D. Blue lotus added.
E. White lotus added.

For the varieties of treatment of flowers, see *Anc. Eg.* 1917, I.

50. A. PAPYRUS, OPEN HEAD. This appears in the beginning of the iiird dyn. (Zeser), with a single stem, of curved triangular form, and widespread head (86). In later times the single triangular stem seemed too slight, and a plain shaft was used instead, yet the single stem motive remains, as shown by the whole capital being a single plant. The form did not become usual till later in the xviiith dynasty, as in the Luqsor colonnade of Amenhetep III (87). This was slightly wider, in the bell of the capital, under Taharqa (88). The capital is copied from the spread head of filaments, with artificial sepals painted around the base, which imply a single head. The proportions, to the maximum diam. as 100, are as follow :—

Dyn.		Height Shaft	Cap.	Abacus	Width Top	Cap.	Abacus	Bands	Inter-space
iii	Saqqara, Zeser . Ph.	645	180	—	90	118 / 250	—	—	—
iii	Saqqara, Zeser . (fig. 86)	416	150	40	95	220	95	—	—
xviii	Luqsor, Amen-hetep III . . Ph.	512	108	31	93	178	90	43	132 / 166
xviii	Luqsor, Amenhe-tep III colonnade Ph.	446	114	85	83	174	—	37	124
xix	Karnak, Sety I . L.D.	457	90	41	88	200	75	50	106 / 174
xix	Ramesseum, R. II Ph.	379	88	24	90	170	90	39	103 / 118
xx	Medinet Habu, R. III . . Ph.	290	95	30	85	145	94	33	82
xxv	Karnak, Taharqa Ph.	530	99	45	81	196	79	—	100 / 138
Ptol.	Kom Ombo . Ph.	415	97	31	91	170	89	35	121
Ptol.	Philae . . W.A.	410	94	25	85	153	81	36	—
?	Basalt model U.C.	—	75	—	88	155	—	34	—
Ptol.	Green glaze U.C.	—	89	61	88	172	177	—	—
Ptol.	Green glaze U.C.	—	52	16	88	126	133	—	—

The two amounts of interspace are along the row, and across the axis; as this order was used for axial avenues, the difference is notable. The width of the capital, overhanging more than a whole radius, was a needless load on the column, and when exposed always broke away.

PAPYRUS, OPEN HEAD, CLUSTERED STEM. This is only recorded from Amarna (89), in limestone copies of an assembly of glazed sections encircled by gilt bands. Being only seven feet high, it was evidently in use for rooms. The dimensions are :—

402 63 . . . . 92 102 to 146 wide.

51. B. PAPYRUS, UNOPENED HEAD. So far, there is no example before the vth dynasty (90). The motive is eight papyrus stems, bundled at the top ; the basal leaves and the sepals show this plainly. The triangular form of the stem is observed, implying that each stem is packed with a flat side against a centre mass, and a ridge outward. The form became degraded in the xviiith dyn. and onward, so that it is difficult to distinguish it from the lotus pattern (91). The examples vary as follows :—

Dyn.		Height Shaft	Cap.	Abacus	Width Shaft	Cap.	Abacus	Bands	Inter-space
v	Abusir, Sahura .	481	148	38	78	109	113	—	—
v	Abusir, Sahura .	423	118	33	87	102	98	42	—
xii	Benihasan . W.A.	536	114	15	74	92	80	36	311
xviii	Karnak; Tehut-mes III . Ph. L.D.	417	128	26	84	105	88	47	189
xviii	Luqsor, Amen-hetep III . Ph.	384	120	46	79	98	80	40	94
xviii	Soleb, Amen-hetep III . L.D.	410	120	42	86	99	74	42	69
xviii	Amarna . . W.A.	227	89	19	86	101	80	26	—
xviii	Amarna . .	340	116	28	—	—	—	24	80
xix	Qurneh, Sety I . L.D. i, 86	292	105	45	86	100	82	33	220
xix	Luqsor, Ramessu II. . . Ph.	421	118	33	79	100	92	42	350
xix	Silsileh, Ramessu II. . . Ph.	288	106	29	85	97	78	30	355
xix	Luqsor, Ramessu II. . . Ph.	428	113	33	83	100	89	—	378

These are distinctively of the papyrus, except from Benihasan, which on the strength of the coloured divisions may be of the lotus.

52. C. PAPYRUS, DEGRADED. The next stage was the abolition of lobes of the capital, making a smooth conical surface, usually covered with hieroglyphs (92). Dividing lines remain in the hall of Sety I ; some arbitrary bands still appear at the Ramesseum, but all trace of detail is lost in the Great Hall of Karnak. The proportions are :

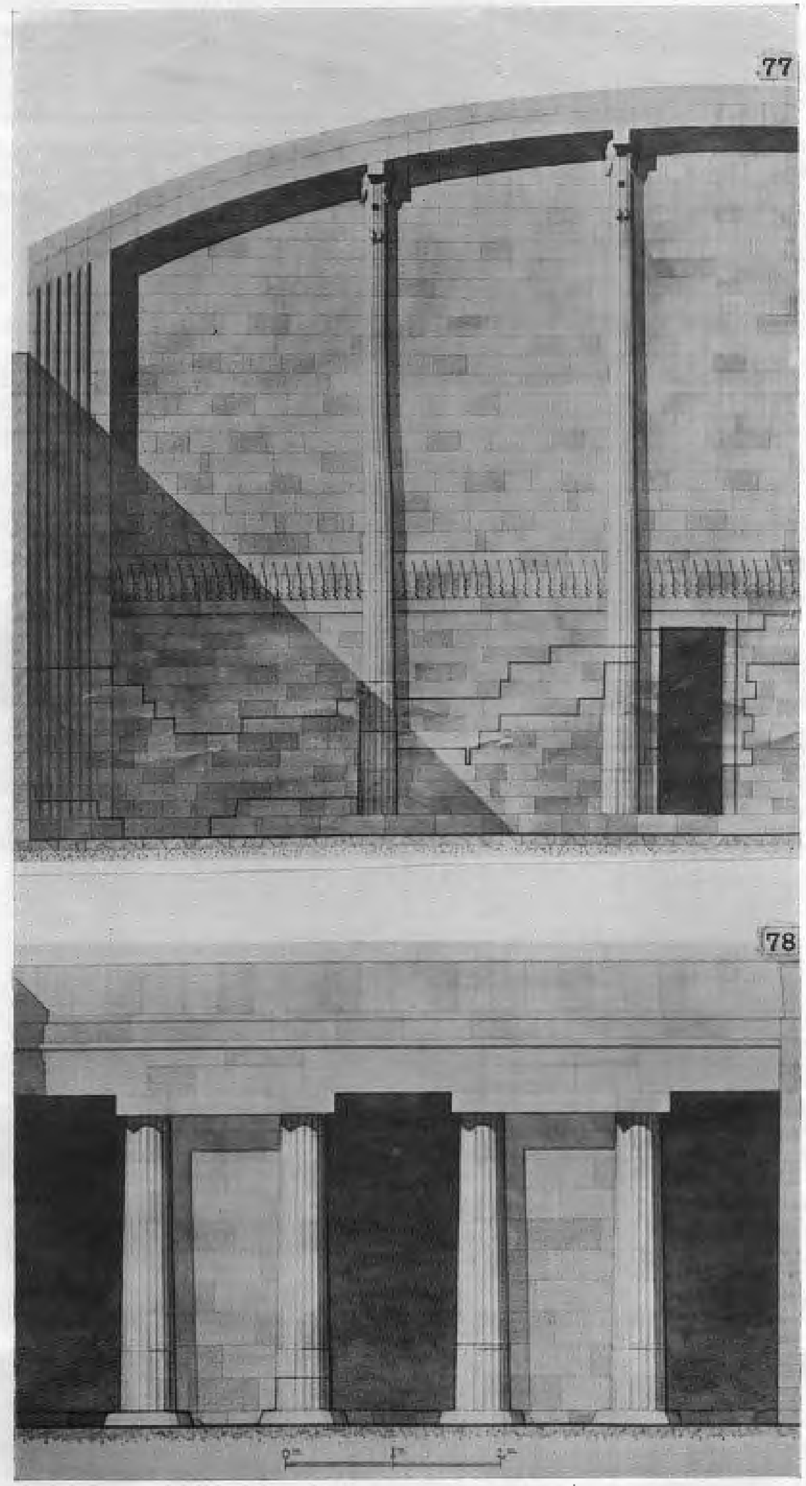
Dyn.		Height Shaft	Cap.	Abacus	Width Top	Cap.	Abacus	Bands	Inter-space
xix	Abydos, Sety I .	402	124	39	89	100	—	—	186
xix	Qurneh hall, Sety I, L.D.	277	89	49	90	101	89	25	211
xix	Karnak, Sety I . L.D. W.A.	304	116	41	80	93	78	35	88
xix	Luqsor, Ramessu II. . . Ph.	352	98	48	79	93	72	35	96
xix	Ramesseum L.D. Ph.	312	90	26	80	98	80	26	95 / 150
xx	Medinet Habu, R. III . . W.A.	228	62	30	88	103	85	24	112
xx	Medinet Habu, R. III (fig. 92) . Ph.	260	80	27	82	96	85	29	87

The width and stumpy proportions are probably due to the inferior stone, and work of the debased age.

53. D. Blue Lotus. This as a column decoration belongs to the Old Kingdom, and is not seen later except at Benihasan. It is finely carved about the vth dyn. with venation over the petals (93), or bounding the petals (94). The lotus has no strength for a support, so it can only be looked on here as applied to a truss of papyrus. The little buds, represented as tucked in below the binding, mark the artificiality of the composition. Yet it is beautiful in the copying of natural form, and a happy adaptation. As it has never been found in position, we know nothing of the details of the shaft.

54. E. White Lotus. The thicker buds of the white lotus were rarely represented. A noble capital found at Memphis (96) has no date of position. From the fine work, it cannot be late, and as it is so closely like the capital of the lampstand of the xiith dynasty (95), it may belong to the same age. It occurs, more slender, in the painted capital at Bersheh (97). It was parodied in the Ptolemaic period (L.D. I., cvii). Between the buds of the white lotus, there are inserted in low relief the flowers of the blue lotus.

55. Hat-hor. The devotion to Hat-hor dates from the beginning of the ist dynasty (see palette of Nar-mer). It is therefore not surprising to find the Hat-hor capital already in the reign of Zeser, iiird dynasty (C.E. fig. 5) (77, 98). The long locks on each side show the intention, but the face has never been carved, and is left in the block. Just the same neglect is seen in the shrine of Hat-hor at Speos Artemidos, where the head and shrine over it are left blocked out (99). At Deir el Bahri, heads of Hat-hor are placed on the top of very tall columns flanking a doorway (N., *D.B.* ciii). Hat-hor heads are also on columns at El Kab (L.D. I., 100), and at Sedeinga (xiiith dyn.), and on square pillars at Abu Simbel (xixth



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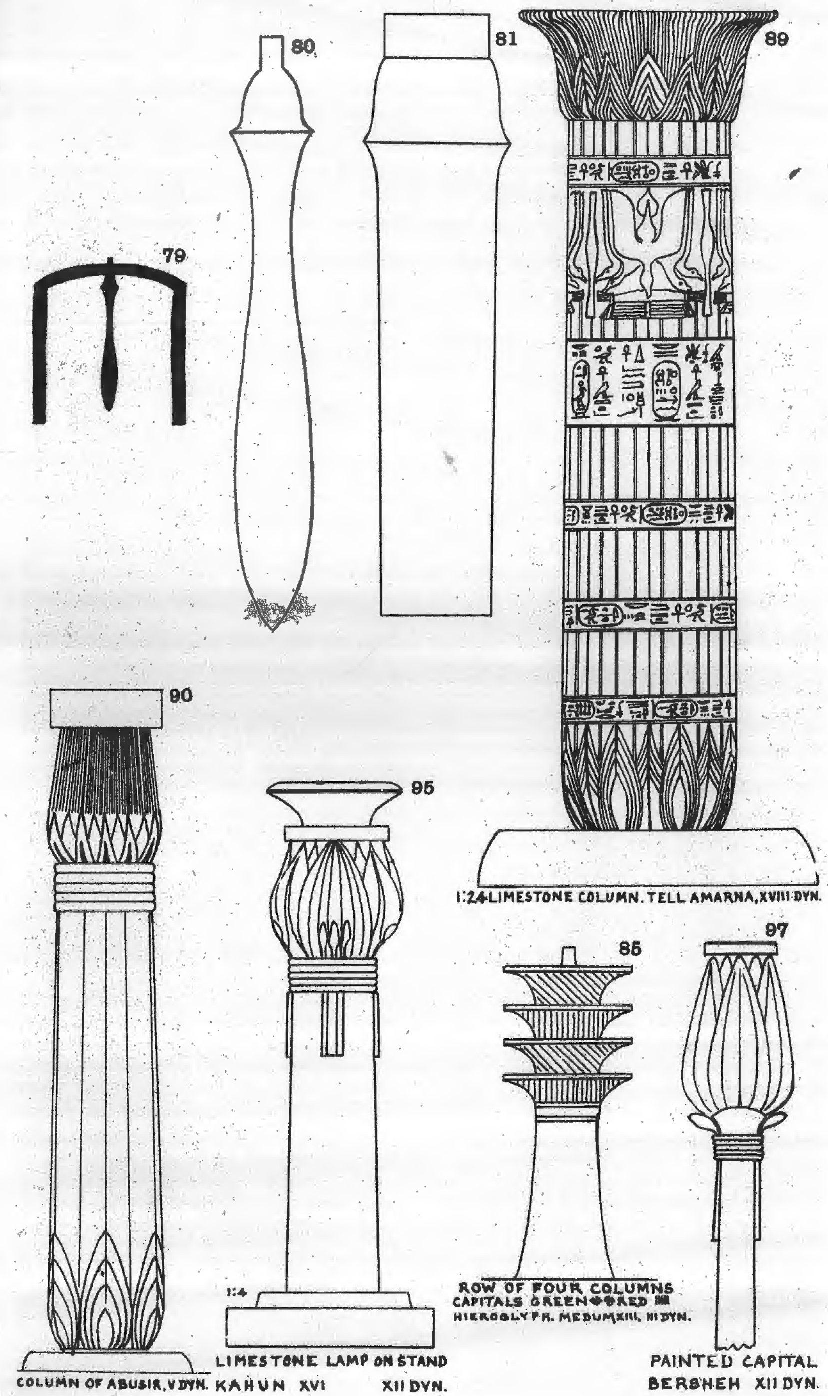
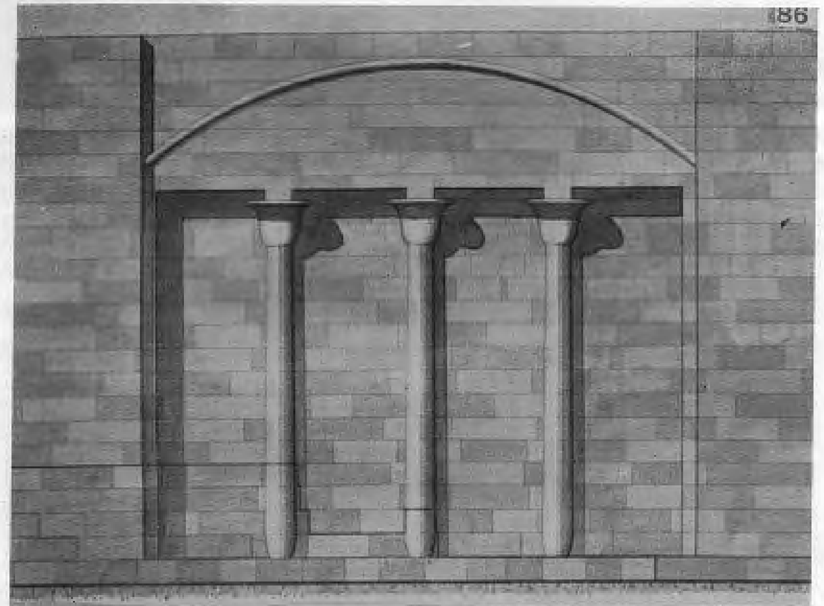

79
80
81
89
1:24 LIMESTONE COLUMN. TELL AMARNA, XVIII DYN.
90
95
85
97
ROW OF FOUR COLUMNS
CAPITALS GREEN RED
HIEROGLYPH. MEDUM XIII. III DYN.
1:4
COLUMN OF ABUSIR, V DYN.
LIMESTONE LAMP ON STAND
KAHUN XVI XII DYN.
PAINTED CAPITAL
BERSHEH XII DYN.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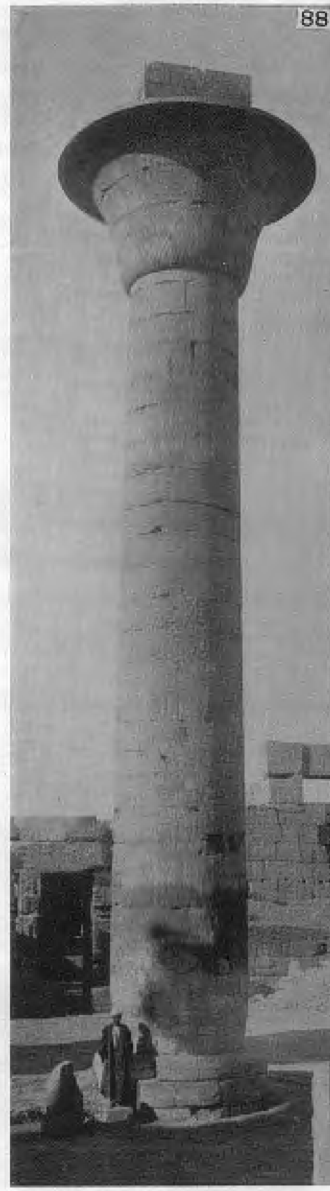

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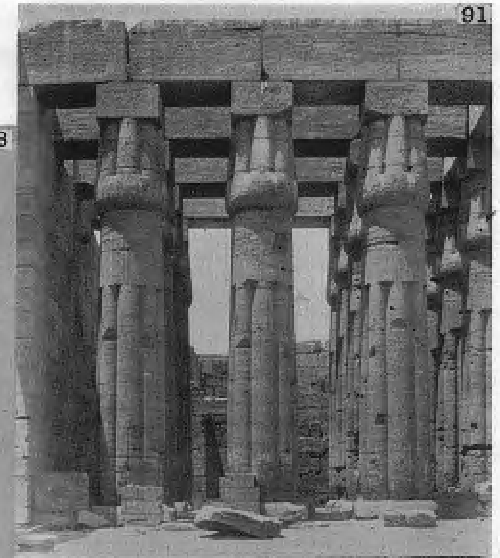

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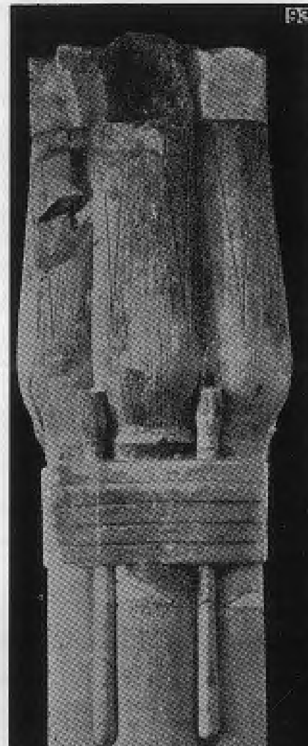
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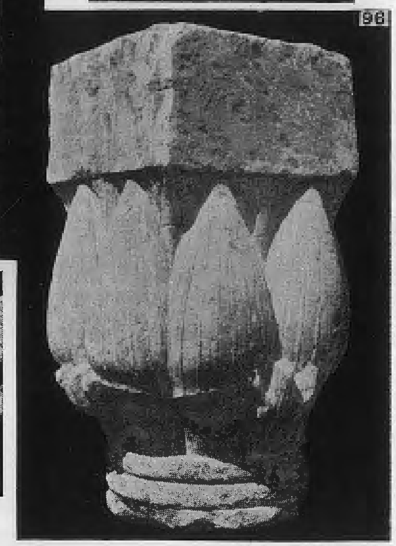
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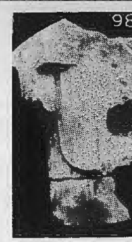
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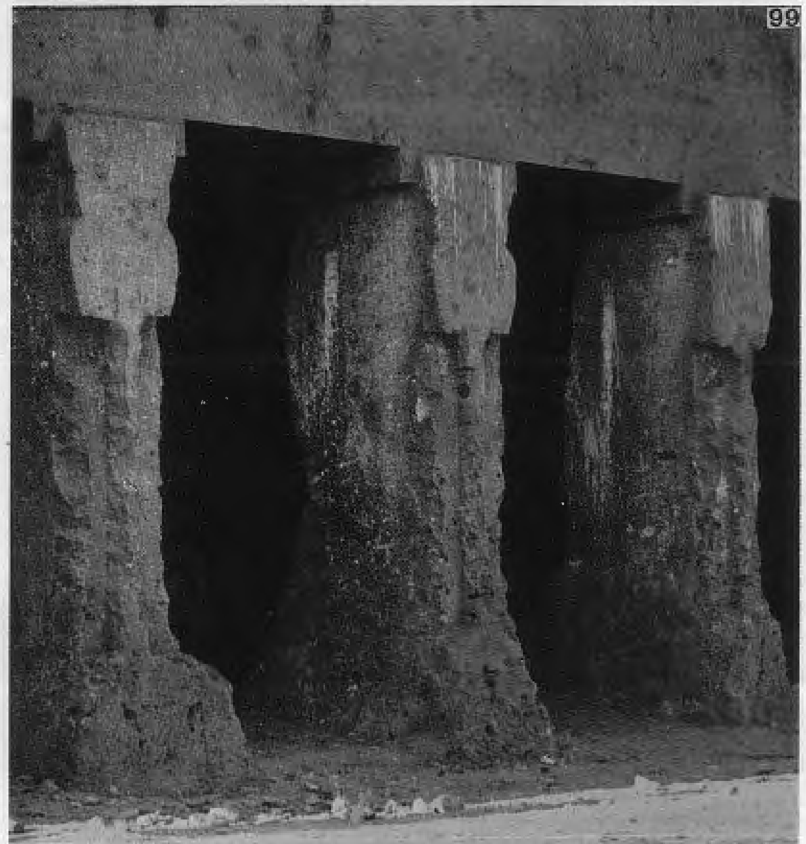
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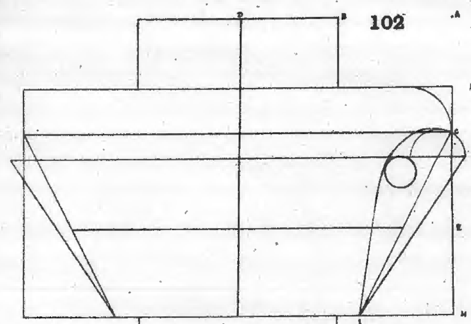
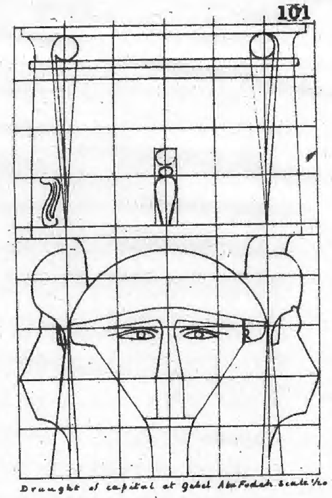


102

Draught of capital at Gebel Abu Fodeh. Scale 1/10.



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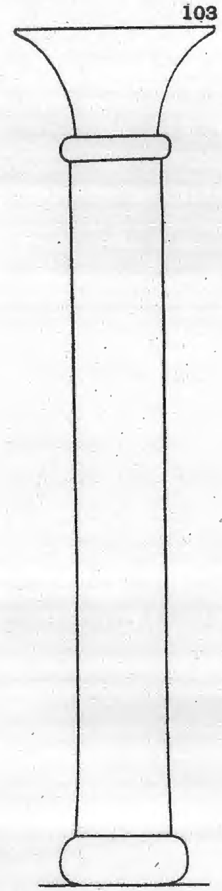
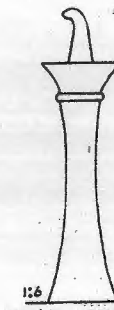
Draught of capital at Gebel Abu Fodeh. Scale 1/10



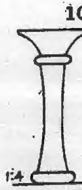
103

1:6 RELIEF COLUMN
KHUFU-KHAF, GIZEH
IV DYN.



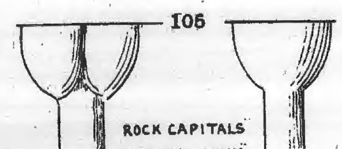
104

1:6
MODEL LAMP ON
STAND. LABYRINTH.
XII DYN.



104 A

1:4
BOWL ON STAND
GIZEH IV DYN.



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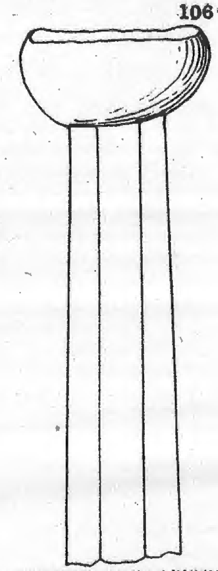
ROCK CAPITALS
ISBAYDA, VI DYN.



106

1:6 LIMESTONE COLUMN. KAHUN: XIID.

dyn.). In the close of Ptolemaic work the great example is the court of the Hat-hor temple at Dendereh (100). As that was occupied in Coptic times, it is difficult to find an unmutilated face. The proportions are as follow :—

Dyn.		Height Shaft	Cap.	Sistrum	Width Top	Cap.	Sistrum	Inter-space
iii	Saqqara, Zeser (figs. 77, 95) . . .	17·80	100	—	42	100	—	520
xviii	El Kab, Amenhetep III	276	46	77	—	81	54	337
xviii	Sedeinga, Amenhetep III	270	130	58	94	131	105	169
Ptol.	Dendereh . . .	344	112	96	87	114	82	105

The drawing of a Hat-hor capital in a quarry at Gebel Abu Fodeh shows how work was designed (101) and blocked out before final carving in the round (Petrie, *A Season in Egypt*, xxv). Along with this is another design of a capital (102) which might be for a papyrus column or possibly for a palm column. The meaning of the constructive lines is not clear ; AF = FG = GE, and AE = radius. 2HJ = CH. On G line, axis to G = FH. On G line semicircle = $\frac{1}{4}$C to axis. 3DB = BJ. The motive or system of these connections is not obvious.

Other figures are also sometimes added to architecture, as Bes at the birth-shrine of Dendereh. The florid complications of ornament on Ptolemaic and Roman capitals are merely artistic effusions without meaning.

Another form which is decorative, though not structural, is the lampstand (103), which appears in the ivth dynasty ; and was carved in the solid, with a flame as well, in the xiith (104). Bowl lamps on tall stands are painted in the tomb of Hesy (iiird dyn. Q.H. xvi).

A strangely clumsy form of capital is the crutch form, used in rock tombs (105), and on a column at Kahūn, xiith dyn. (106).

CHAPTER VII

STRENGTH OF MATERIAL

56. PROPORTIONATE STRENGTH. We have seen that the relations of pillars and columns to the interspace vary much but, so far, we have only been observing proportion. When we take into account the absolute dimensions, we reach a controlling factor of the proportion. It is obvious that a small model cannot be copied on a colossal scale without breaking down by its own weight. The larger the scale, the narrower must be the interspace in proportion. A higher hall than that of Karnak would become choked with columns, if of weak sandstone; only granite would leave space below for a larger scale.

In the following table, the whole height of the shaft, capital and abacus, are taken together for comparison. Dimensions are in metres. P marks the papyrus capitals, G the polygonal columns, H Hat-hor capitals.

Dyn.	Columns	Height	Inter-space	Style
xxv	Karnak, Taharqa I	20·7	128	P
xviii	Luqsor, Amenhetep III	19·8	149	P
xix	Karnak, Sety I	19·4	140	P
Ptol.	Dendereh	14·5	137	H
xix	Karnak, Sety I	14·2	113	P
xix	Luqsor, Ramessu II	12·3	96	P
xix	Ramesseum	11·3	111	P
xviii	Luqsor, Amenhetep III	11·3	96	P
Ptol.	Kom Ombo	10·9	135	P
xix	Ramesseum	9·7	98	P
xix	Abydos, Sety I	8·0	186	P
xix	Ramesseum	7·3	146	P
xviii	Karnak, Tehutmes III	6·3	176	P
xix	Qurneh, Sety I	6·3	220	P
xix	Qurneh hall, Sety I	6·0	211	P
xii	Hawara, Labyrinth	6·0	202	P
xii	Benihasan, octagon	5·8	181	G

Dyn.	Columns	Height	Inter-space	Style
xviii	Deir el Bahri, 16 sides	5·5	188	G
xii	Benihasan, 16 sides	5·3	294	G
xviii	Karnak, Tehutmes III	5·1	192	G
xii	Benihasan, 16 sides	4·7	240	G
xii	Benihasan	3·0	311	P
xviii	El Kab, Amenhetep III	2·8	290	G
xviii	Amarna, cluster	2·2	410	P

(Benihasan is all rock cut)

Dyn.	Pillars (not rock cut)	Height	Inter-space
xix	Ramesseum	10·2	82
xx	Medinet Habu	8·3	99
xix	Abydos, Sety I	5·4	168
iv	Gizeh, Khafra	4·4	253
xix	Qurneh, Sety I	4·3	212
xviii	Karnak, Tehutmes III	4·0	186
xviii	Deir el Bahri, low	3·9	148
xviii	Deir el Bahri, high	3·8	195
xviii	Medinet Habu, Tehutmes III	3·5	160
xix	Sety I tomb, rock cut	3·2	156
xix	Sety I tomb, rock cut	3·0	173
xix	Sety I tomb, rock cut	3·0	188

Here a sharp change takes place above 8 metres high, interspace being hardly over 100; below the 8 metres, the relative spacing is steadily wider in the lesser heights. This points to the difficulty of getting architraves to harmonize with the proportion of great heights.

It seems, then, that the strength of architraves is much the same up to 8·0 m. At greater heights they were left weaker and thinner than they should be, in order to gain space between. The pillars are placed closer than the columns. The polygonal pillar is limited to 5·8 m. high, perhaps because it would look too massive and overbearing on a larger scale. Roughly, the height of columns now lost can be read off, within about $\frac{1}{8}$ either way, from interspaces of over 170.

57. ABSOLUTE STRENGTH. We have seen how the strength was adapted to the proportions, but the absolute strength must be considered. The best way to regard this is to conceive of the whole load of architrave and roof being piled up on a column, of the same area as the column. Thus the total pile on each column base is

5

equal to a column between 9 and 31 metres high. The instances for which we have the data are, in metres :—

		Roof Area per Column	Ratio of Column to its Roof Area	Depth of Stone on Column	Height of Column	Total Stone on Base	Ratio of Top Pressure to Base Pressure	Taper needed at Top, Base 100
xviii	El Kab, Amenp. III	6·0m	15·8	6·2m	2·8m	9·0m	69	83
xix	Qurneh, Sety I	19·6	15·2	15·2	6·0	21·2	72	85
xix	Abydos, Sety I	17·0	11·0	12·1	8·0	20·1	60	78
xix	Karnak, Sety I	30·2	5·3	8·5	14·3	22·8	37	61
xix	Ramesseum	20·5	13·3	7·7	6·0	13·6	56	75
Ptol.	Ombos	24·6	8·7	17·8	10·9	28·7	62	79
Ptol.	Dendereh	21·0	6·4	16·5	14·5	31·0	53	73

Taking the first instance, the area of the roof supported by one column is 6 square metres ; the ratio of this column to the area it supports is 1 : 15·8 ; the weight of the architrave and roof, if piled up on the column area, would be 6·2 m. high of stone ; the height of the column itself is 2·8 m. so the total pressure on the column base is equal to 9·0 m. height. The ratio of the pressure at the top to that at the base is 69 : 100 ; therefore the column should taper in the diameter proportion of 100 to 83.

The heaviest pressure at Dendereh equals 31 m. of stone on each column base. We do not know the crushing pressure of Nubian sandstone, but as chalk would crush under 100 to 200 metres of itself, and baked brick under 200 m. height, there may be a factor of safety of 2 or 3 to 1.

58. Causes of Failure. Nearly all Egyptian buildings have suffered from wilful damage, such as the blowing up of pylons by Mehemet Ali. When we compare the state of the buildings which have retained their roof, such as the temples of Dendereh and Edfu, these are as sound as when set up.

The constructive failures are due to hollowing drums of columns so that all pressure comes near the edge, or rubble hearting inside a pyramid or pylon. A main cause of failure is the stripping of a roof, and so exposing architraves to unequal temperatures ; thus the lower face is forced off, weakening the beam.

Of natural changes, the continual rise of salts from the soil is the most deadly ; the moisture evaporates and the salt crystallizes, making limestone and sandstone go to powder, and granite break into crystals. When the stone is portable it should be laid face down on damp sand, and the salt will all pass out on the back ; where the stone is in a building, it should be frequently plastered over with wet sand ; the surface salt will then all pass into the sand, and can be removed, and repetition will gradually remove it all. The most fatal treatment is that in museums of placing stone cemented on to a wall (as Serapeum steles at the Louvre), when all the damp works out on the face, covering it with crystallizing salt.

Earthquake has not made great displacements, as the obelisks still standing are evidence ; but it has been extremely severe in wrenching, as all the deep beams of granite over the King's Chamber in the Great Pyramid are snapped through at the south end, or else dragged out in the upper chambers. The whole roof hangs now by merely catching contact, and another great earthquake might bring it down.

The most distressing damage is the vertical fissuring up the whole height of the sides of the west gate of Karnak. This is probably due to the heating by conflagration of the great gates, followed by the modern blowing up of adjacent buildings, which shook the whole region.

CHAPTER VIII

ROOFING

59. Slabs on Walls. The earliest stone roofing is always of slabs on walls, the wider spaces having to be met by overlapping. Where a wall was sloping, as in the Grand Gallery, the roof slabs are each retained by tilting into a notch on the wall.

Joints in compound roofs were usually packed with a slip of stone inserted at the joint; sometimes the joint edges rose above the general level, to prevent rain reaching the joint.

60. Architraves. These beams, which supported the ends of the roofing slabs above columns, usually extend to the axes of the columns. At Luqsor, in the colonnade of Amenhetep III, the architrave is 6·90 m. long, while it bridges 4·12 m. between the columns; at Karnak in the Great Hall, the architrave is 7·30, but the span 4·21.

The architrave on a large scale is usually formed of two parallel beams side by side, for easier handling without sacrificing strength; see Luqsor, Karnak, Ramesseum, also the Parthenon. In the lintel of the pylon, where there was no added load, two superposed architraves could be thinner.

Proportions of Architraves. The table opposite is in the order of the clear span, as that is the most essential detail. The dimensions are in metres.

Cols. I to VI explain themselves. VII is the load on the architrave distributed as a pile upon it, and so measured in metres. VIII, beam height for self-support of the beam. In X, the span of roof, between lines of

	I Column Base Diam	II Column Height	III Architraves Length	IV Architraves Span	V Architraves High	VI Architraves Wide	VII Load= Height	VIII For Self-support	IX Roof Deep	X Roof Clear Space
M. Habu, T. III, pill.	0·89	3·49	2·31	1·42	0·83	0·88	1·40	0·41	0·57	3·0
D. Bahri, T. III, pill.	0·79	3·80	2·33	1·65	0·61	0·79	2·15	0·29	0·68	1·7
Karnak, T. III, polyg	0·86	5·15	2·5	1·7	0·67	0·80	2·50	0·31	0·58	2·65
Karnak, T. III, hall .	—	—	2·95	2·0	0·96	1·04	1·70	0·58	0·75	1·98
Luqsor, Am. III .	2·02	11·3	3·60	2·03	1·52	1·60*	—	—	—	2·6
Ramesseum, pillar .	2·38	9·76	4·28	2·10	1·47	2·20*	—	—	—	—
Karnak, T. III .	1·08	6·35	3·07	2·11	0·98	0·91	—	—	—	—
Philae, outer pylon .	—	—	3·4	2·33	0·81	—	—	—	—	—
Ombos, Ptol. . .	1·90	10·95	4·1	2·44	1·6	1·62	2·76	0·97	0·88	3·47
M. Habu, window .	—	—	5·48	2·45	0·96*	—	—	—	—	—
M. Habu, colonnade	2·34	10·3	4·65	2·52	1·22	1·9*	—	—	—	—
Qurneh, portico .	1·43	6·30	3·85	2·57	1·1	—	1·96	0·63	0·7?	2·63
Luqsor, A. III .	2·02	11·3	4·17	2·6	1·52	1·6*	—	—	—	2·6
Karnak, T. III .	1·08	6·35	3·6	2·64	0·98	0·91	—	—	—	—
Abydos, Sety I .	1·40	8·0	4·0	2·76	1·1	1·4	2·15	0·64	0·7?	2·9
Dendereh, Ptol. .	2·07	14·5	4·85	2·80	1·54	2·44	—	—	—	—
Ramesseum . .	1·72	7·2	4·3	2·90	0·99	1·33	1·83	0·59	0·49	3·63
Luqsor, 1st court .	2·46	12·3	4·8	3·03	1·6	1·77	—	—	—	—
M. Habu, 2nd door.	—	—	5·95	3·07	1·26	—	—	—	—	—
Ramesseum, pillar .	2·38	9·76	5·5?	3·30	1·47	1·05	0·72	1·21	0·32	2·7
M. Habu, door .	—	—	4·15	3·35	1·30	—	—	—	—	—
M. Habu, door .	—	—	5·48	3·35	1·45	—	—	—	—	—
Karnak, R. II. .	2·70	14·26	5·70	3·50	1·80	2·20*	2·50	1·17	0·9	3·9
Qurneh, portico .	1·43	6·30	4·60	3·56	1·1	1·16	1·96	0·63	0·60	2·63
Ramesseum . .	2·04	11·3	5·7	3·70	1·5	0·62	2·88	0·88	0·62	4·52
Ramesseum, pylon .	—	—	6·3	3·75	1·21	—	—	—	—	—
Karnak, Khonsu .	1·7	9·0	5·25	3·78	1·13	1·47	2·2	0·66	0·68	3·78
M. Habu, court door	—	—	8·7	3·80	1·6	—	—	—	—	—
M. Habu, 2nd door	—	—	6·0	3·82	1·22	—	—	—	—	—
Luqsor, A. III .	2·02	11·3	5·42	3·85	1·52	1·60*	—	—	—	2·6
Luqsor, A. III .	3·0	19·8	6·90	4·12	1·83	2·60*	—	—	—	5·4
Karnak, R. II. .	3·37	19·4	7·30	4·21	2·07	3·08*	4·3	1·18	1·3	7·13
Qurneh, portico .	1·43	6·3	5·65	4·27	1·1	1·16	1·96	0·63	0·6	2·63
Edfu, pylon . .	—	—	8·42	5·36	2·06	—	—	—	—	—
Karnak, Khonsu .	—	—	8·5	5·54	0·97	—	—	—	—	—
Dendereh, portico .	2·07	14·5	7·95	5·95	1·54	—	—	—	—	—

* Marks one of two equal beams together.

architrave, is often 2·6 or 2·63, 2·65 m., nearly half the instances; this is 5 cubits, and shows that the architects reckoned that as a normal element in the design.

The primary proportion of an architrave is the increase of depth to agree with greater span. Four times the span requires double the depth of beam to be equally

strong with a constant load, but it requires four times the depth if the load is the weight of the beam itself, increasing with depth and length. To see the relation of these examples, they are set out in a diagram (fig. 107). Each mark here may be regarded as the middle of the top of a beam, which lies on the base and ends in the left-hand corner, the vertical scale being double of the horizontal.

The X marks denote a beam bearing a top load.

The O marks, a beam only carrying its own weight.

The • marks are lintels of gateways.

The - marks are roof slabs.

The curves guide the eye to see what examples have similar proportions; the middle curve with 4 × strength of lower, the upper one with 14 × strength of lower.

The breaking strain at the bottom would be that of hard English sandstone; the soft Nubian stone, with little cohesion, might be half-way up to the weakest line here. Looking at the free architraves, marked O, the lightest are the limestone; the soft sandstone needs more bulk. The factor of safety of columns was 5 to 15 times the crushing strain, for architraves probably 5 to 10 times the limit. It is only the misuse, and exposure of inner structure, which has produced failure.

61. OVERLAPPING ROOFS. The earliest system of stone roofing was by corbelling over, each course projecting a little; see the chamber of Sneferu (108), with projections of 5 to 8 ins. on courses of 21 to 24 ins.; also the Grand Gallery of Khufu. This type is only stable when the centre of gravity (C.G.) of the whole of the side is above the wall below it.

Curved Overlapping. This was done by cutting out a smooth curve in the overlapping stones, and was not practised before the xviiith dyn. At Deir el Bahri the lapping blocks were further secured by piling weight

on the haunches (109), and using the piles to support a gable roof of slabs butting above.

In the Mykenaean *tholoi*, the overlap was held in place by being part of a ring of stones at each course, which prevented collapse, a kind of horizontal arch.

Ridge Roofs. The acquirement of large blocks in the ivth dynasty led to the simplest roof of butting slabs forming a ridge. In the Queen's Chamber of Khufu (110), the roof slabs are so long that the C.G. is over the wall, and hence there is no pressure together at the top. The same is almost the case in the ridge over the King's Chamber (111). The same form of roofing is in the pyramids of Khafra and the later kings, also in the super-chamber of Amenemhat III (112). In all instances these sloping slabs are much deeper than the width of the beam, those of the xiith dynasty being 371 ins. long, 88 deep, and 41 or 49 wide, and weighing about 40 tons. The angles of such roofs are:—

Chamber of Khafra . .	21° 12′
Queen's Chamber, Khufu .	30° 26′
King's Chamber, Khufu .	33°
Amenemhat, beams . .	51° 15′

In the pyramid of Menkaura the underside of the granite beams is cut out arched, and the slope between the ends is 29° 34′.

Flat Roofs Arched. At Abydos, Sety I had beam roofs cut into an arch below, beams 7 metres long, 1·14 wide, and 1·52 deep. The arch extends down into the supporting courses. This is not like fig. 109, as there is overlapping but no beam. The arch form of roof is in the rock-cut tombs of Benihasan, and the earlier ones of Antaeopolis, both most likely copied from brickwork.

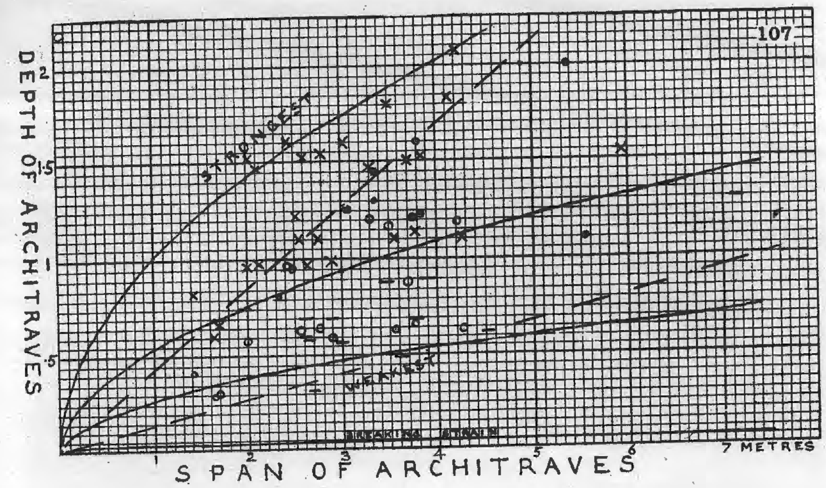
62. ARCH OF BRICK. The true arch was made in brickwork, at least as early as the beginning of the iiird dynasty,

in the tomb of Neterkhet, Zeser. The bricks were spaced at the outer ends with pebbles (113). On a larger scale in the vith dynasty, there is the long arched tunnel used regularly in tombs (114). In the xiith dynasty there are arched buildings represented, one with 9 *zed* columns across the front (115). As a relieving arch in brick building, it is seen on a large scale across the tomb of Amenemhat III (112), over 40 ft. wide. The house models also show the arch freely used in the xith dynasty (116). There is no question that the arch was used early, even in Neolithic times in Europe (*Decorative Patterns* lvi, x 2–4).

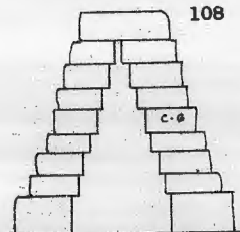
In the xixth dynasty, arched tunnels were used on a grand scale, around the Ramesseum (117). The four courses of arch were laid slanting in opposite directions (118), to prevent cracks running through. On the top was a thick bed of sand and broken pottery, to absorb any rain, which was left to dry off rather than risk drains on bricks. A small amount of moisture was welcomed in brickwork, in order to be plastic rather than brittle under strains.

The size of arch is usually 12 ft. but sometimes 16 ft. The height is 15 ft. inside. The galleries were lighted by holes in the roof, at intervals of 12 ft. These holes cannot have been over 13 ins. square, or less if they had a wooden lining: probably only 6 or 8 ins., so that not even a child could be lowered through them.

The method of building was by laying a tilted arch against an end wall (119), the bricks holding up, by adhesion of mud-mortar, long enough to complete one ring. The next layer must have been begun at the opposite end, for the tilt. The theoretical form of the arch, a catenary curve, was closely followed by good instinct in the Egyptians; the rigidity of the material indicates at what level the curve should be started (120), but the curve itself is invariable.

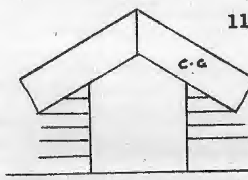


108



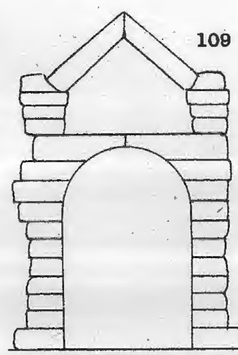
1:100 CHAMBER ROOF SNEFERU. III DYN.

110



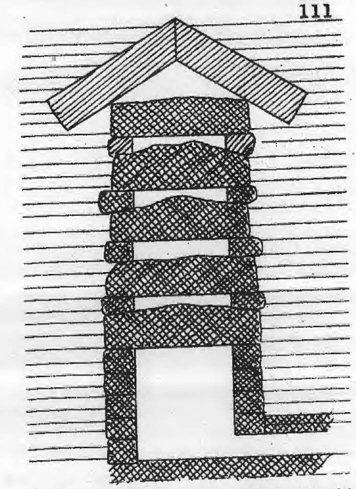
1:200 LIMESTONE ROOF. KHUFU. IV DYN.

109

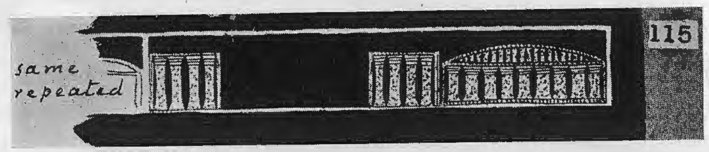


1:100 LIMESTONE BARREL ROOF, WITH RELIEVING ROOF ABOVE. HATSHEPSUT XVIII DYN.

111



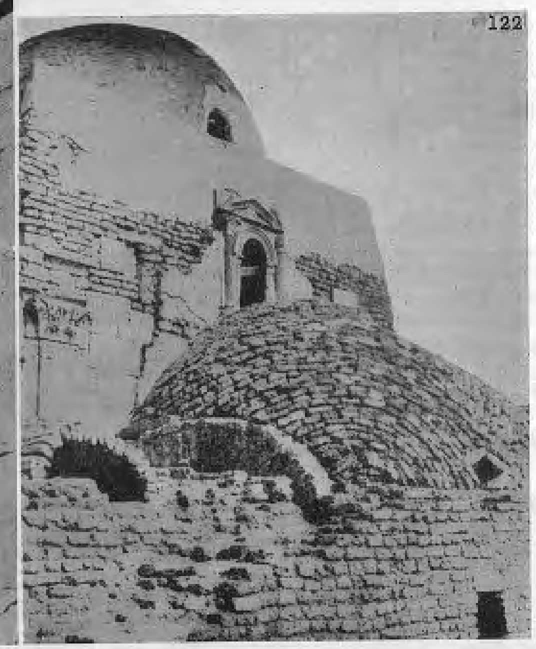
1:200 SUPERIMPOSED ROOFS. KHUFU. //// LIMESTONE XXXX GRANITE. IV DYN.

115


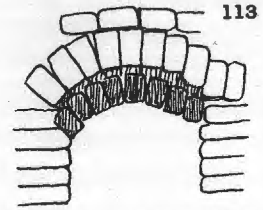
114


116


121

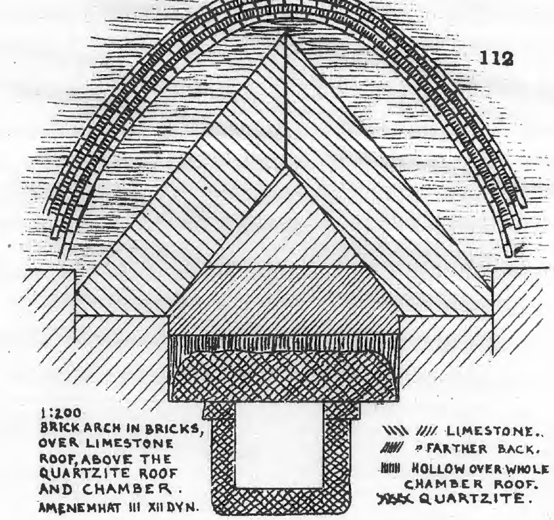

122


113



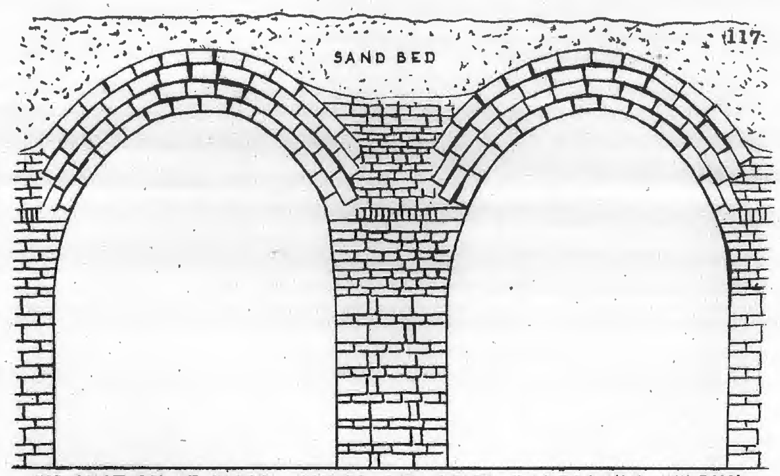
1:70 BRICK ARCH Bt KHALLAF. III DYN.

112



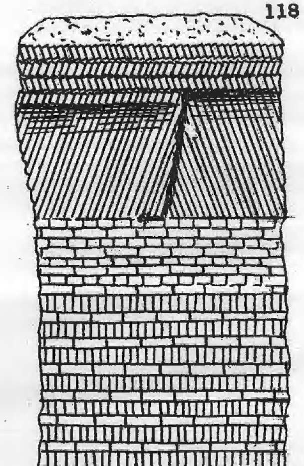
1:200
BRICK ARCH IN BRICKS, OVER LIMESTONE ROOF, ABOVE THE QUARTZITE ROOF AND CHAMBER. AMENEMHAT III XII DYN.

117



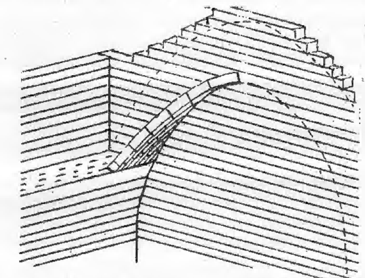
1:100 SECTION OF BARREL-ROOFED GALLERIES, RAMESSEUM. XIX DYN.

118



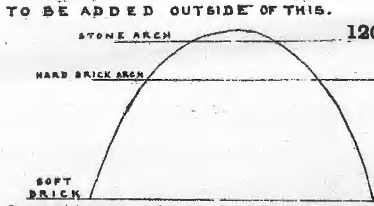
LONG SECTION OF GALLERY
PART OF INNER COURSE REMOVED TO SHEW CROSSING OF COURSES.

119



MODE OF STARTING A SLOPING ARCH WITHOUT CENTERING: THREE MORE TO BE ADDED OUTSIDE OF THIS.

120



CATENARY, CUT AT DIFFERENT LEVELS FOR ARCHES FIT FOR DIFFERENT MATERIAL

Brick Doming. This appears in an unfinished brick tomb at Qurneh, of the xviiith dynasty; the dome was regularly used at Ur more than a thousand years earlier. A good example of the later time is at the Deir el Ahmar or Red Monastery (122), where the brick structure shows the method of starting at the corners and closing to the centre of the dome. It is of the reign of Arcadius.

CHAPTER IX

DOORS AND WINDOWS

63. Doorways. The Egyptian doorway is always vertical at the sides, and not narrowing upward as in some Greek and Etruscan doorways. Along the sides is usually a broad and shallow border projection, which is doubtless copied from the stone doorways set in brick walls. Above the door is a lintel, which is generally less in height than the lateral border. For outer doors and gates there is also a torus roll and cavetto cornice above the lintel (23).

The largest doorways known are at Karnak. The river pylon has perished, but the entry of the Great Hall was about 82 ft. high to the top of the cornice, and 50 ft. wide across the front; the doorway was 60 ft. high and 23 ft. wide. The two gates extended to the top, as there is no trace of a projection for the pivot. The pivot posts ground against the corners of the wall; the gates, of course, opened back into recesses in the jambs. Each valve was 60 ft. high by 14 ft. wide. If they were built in position, the slightest scantling possible would be 3 ins. tapering above to 1 in. boards, and half as much more for the framing. This would take 210 cubic feet, and the pivot post must have been at least 40 ft. more: amounting to about 6 tons, with about ½ ton of bronze nails and fittings. Probably it would be about double of this for practical use. To swing a door of a dozen tons on its pivot, with friction against the stone sides, seems almost superhuman.

The method of pivoting was by the post projecting into

a cup-shaped pivot-hole below, and through a cylindrical hole in the lintel. The bearing on the cup was usually too shallow for the thrust of the door weight, and made the pivot beam kick out against the jamb. Doors that could be handled were usually set up by skewing, so that the top of the post could go up into the lintel, and then by dropping the door pivot into the cup below: this is well seen in the threshold of Pepy (*Abydos* II, liii). In the granite temple of Khafra, the pivot block is flat polished black basalt; how the thrust of the door was maintained is not visible.

Conical pivot holes were used from the iind dynasty or earlier (*Hierakon*. iii, 36).

64. Proportions. Taking the width of a doorway as 100, the proportions are :—

Dyn.			Height	Projection of Side	Projection of Top	Width of Cornice
xii	Ameny, inner shrine	R	140	51	62	—
xx	M. Habu, tower	D	154	31	44	—
Ptol.	Dendereh, pylon	C	170	—	26	37
xviii	M. Habu, T. III	P	182	43	33	37
xix	Karnak, R. II	D	182	—	—	—
Ptol.	Karnak, Khonsu	C	188	53	—	—
xix	Abydos, Sety I, recess	R	203	53	84	—
Ptol.	Deir el Medineh	C	205	50	40	69
Ptol.	Philae, N. pylon	C	230	63	50	33
Ptol.	Kom Ombo	D	235	(92	162	90)
Ptol.	Edfu, pylon	C	239	62	37	48
xviii	D. Bahri, recess	R	244	55	69	32
xviii	D. Bahri, colonnade	P	255	54	46	44
xix	Karnak, great gate	C	261	59	52	45
Ptol.	Philae, side pylon	C	263	59	54	—
Ptol.	Philae, S. pylon	C	270	70	56	73
Ptol.	Karnak, Euergetes pylon	C	270	61	51	63
xx	M. Habu, 1st court	C	291	56	43	49
xx	M. Habu, 2nd court	P	296	58	46	24
x	Antaeopolis, tomb B	D	307	—	—	—
x	Antaeopolis, tomb A	D	355	—	—	—

Those marked C are pylons or great gates with cornices; D are doorways, P are spaces between entrance pillars, R are recesses in walls. The Kom Ombo example is exceptional.

The height varies, apparently regardless of date or

purpose, and no proportion is repeated so often as to prove a canon regularly recognized. The great wall gates are naturally tall in form, as the lintel could not well be longer, while the height had to agree with the great temenos wall.

65. WINDOWS were usually merely plain openings in the wall. In the granite temple of Khafra they were more of the nature of ventilators; a slit a few inches high and 41 ins. wide led from the top edge of the wall into a vertical shaft which opened in the wall face above. The light only dimly entered by two internal reflections from the sides of the shaft. In the Ptolemaic temples which remain roofed, the lighting is by holes in the roof, only 8 or 10 ins. square, widening downward so as to spread the light over the chamber. The great pylon chambers are lighted by a slit, 20 ins. wide and about 5 high, at the roof level, with the wall thickness splayed away in a slope down to the floor (P., *Ath.* xxxv).

The great temples of the xixth dynasty had full lighting by means of a higher roof along the axis with clerestory openings. At the Great Hall of Karnak the clerestory openings are 4·85 m. wide and 5·26 m. high, about 16 × 17 ft. (121). These are filled by two grids of stone, one above another, each grid 16 × 8½ × 1½ ft. The bars are 23 cm. and spaces 15 cm., or 9 and 6 ins. wide. Such a grid weighs about 10 tons.

At the Ramesseum are plain openings 1·3 m. high, and 1·6 to 2·2 m. wide (4 ft. high, 5 to 7 wide). Besides these, lighting the hall sideways, there were also two open courts in the middle of each hypostyle hall, at the sides of the nave, over an area of one bay wide and three bays long; this formed a peristyle court, not a hypostyle as usually regarded. The Karnak hypostyle court has lost its roof, but it exhibits finer work around the middle part, showing its probable exposure.

In Ptolemaic and later times, various forms of grid

appear, in the same taste as the florid capitals. These are high in the walls, as seen in temples and in the representations of houses. The plain bars originated in wooden railings to windows which were used in all ages for keeping out birds.

Architectural fancy varied the forms of the plain grid, and the head of Hat-hor was carved on each upright, or the *onkh* sign of life was placed in the middle with openings designed in patterns around it. In other varieties there were vertical slit openings crossed with diagonal bars, or there were centres encircled by an open rosette. In short, the windows gave to the architect a fair field of fantasy uncontrolled by tradition.

CHAPTER X

PLANS

HAVING now dealt with the parts of a building and its construction, we turn to the plans of the whole in Houses, Temples, and Tombs. The brick house long preceded stone building, and continued in use in all ages.

66. PEASANTS' HOUSES. Though all the simple shelters of the people have long since decayed, yet fortunately at one period we have a series of model houses of baked pottery, in the ixth to xith dynasties, which were placed upon the graves, for the soul to occupy when it wandered forth. These soul-houses have preserved to us the detail of the houses and furniture.

As some terms are needed in description, we can borrow the modern Arabic names ; the *satah* is a roof surrounded by a dwarf wall, the *mulqaf* a raised part of the roof to lead down the fresh breeze, the *'esha* a light shelter on poles placed over an open water-tank. The tank for water is usually modelled in front of the rooms ; an ancient Egyptian song names the pool in the midst of the enclosure, and Oriental houses usually have this, much as we know them in Algiers, Spain, and Italy.

The simplest form is copied from the nomad tent, a mere awning propped by two posts, forming an open shelter to protect from sun by day and chill by night (123).

Next, the roof was utilised by placing a ledge round it, and the *satah* began, and needed access by some kind of steps (124).

Beneath the roof the space was enclosed more or less by walls forming chambers. These being shut in became

hot, and a *mulqaf* was needed to catch the north wind (125).

The square house had existed in the Gerzean period (*El Amrah* x) and even at the beginning of the Copper Age (*Bethpelet* II, ix) ; the tent shelter was thus influenced by a brick building system.

An enclosed chamber was thereby started, and divided into rooms as shewn by separate doorways : while the primitive supports became a portico in front of it. Columns were also placed in the chambers, to support the roof.

The roof *satah* was then developed into an upper storey, which in turn needed a *satah* upon it. The upper floor was the shelter by day when hot wind blew off the ground, and a chair is placed there. The ground floor was cooler at night and the bed is placed there. Up the side is the stairway to the roof (126).

The open court was next walled around, with an outer door. The usual arrangement was for the space under the stair to be a sheltered place for the woman grinding corn.

The brick roof was arched ; the highest roof is flatter at the side where it has a long thrust, and more upright against the house wall. The lower roof is much flatter, as it has weight on the haunches to resist thrust. These variations show an instinct for varying the structure in its details to suit the conditions (fig. 116).

The doorways and open windows had drip-courses or hood mouldings (127), and the narrow windows were closely barred. The columns were always of the palm order. On the roof was the corn bin.

Having considered the ordinary houses of the peasantry, we now turn to workmen's quarters built by official order in a town. These are of the xiith dynasty, at Kahūn, the town of Lahūn pyramid.

The simplest house had an open court ; at the back lay

two rooms, one opening from the other; at the side a larger room, with stairs to the roof. The smaller rooms 6 to 7 ft. wide, larger 13 × 7 ft. This is much the size of a small house in a village now (128). A superior workman's house had larger rooms (129). More ambitious houses of various types had sometimes a doorkeeper's hut at the side of the entrance; passing the stairs, a store-room was reached, and beyond this a court, from which opened a room with inner room (130).

The largest house, for overseers, had a passage to a court, from which opened three rooms, and a door to an inner court with two rooms. All of these courts were probably half roofed for shade, but must have been partly open to give light to the rooms (131).

Many changes were made by blocking doors, and opening others. Owing to the partial desertion of the town, when the public works were ended, the remaining occupants often added on the disused houses to their tenement. The whole number of rooms was probably over two thousand seven hundred; these were in three hundred workmen's houses, ten or twenty larger houses, also store-houses, and ten large mansions, of about seventy rooms each, for the chief officials.

67. MANSIONS were mainly of one plan, and this type in the xiith dynasty is essentially retained even in the palace of the xxvith dynasty (132–34). It is therefore of long standing for great establishments. The plot for a mansion at Kahūn was 138 × 198 ft. of ground. The entrance was to the south, and from it three separate ways led to different portions of the house. To the left was a passage leading to a complex of offices and store-rooms, evidently the servants' quarters. To the right the passage was divided in two by a long wall entirely cutting off the right side of the house, clearly for the women's quarters. The main entrance passage led to the large open court or *mandara* for reception at the north of the house; from this there were separate entrances to the master's private rooms at the left, and to the winter hall and general rooms in the centre. Thus the house was in five divisions carefully separated from each other; these were for the master, the public, the men servants, the women, and the women servants.

Facing the entrance was a recess where the doorkeeper would sit, and his sleeping place, 7 × 4 ft., lay behind it. He here controlled all who went in or out, like a modern *bawwab*. The visitor turned to the right, and went along a passage 93 ft. long and 8 ft. wide to the open court or *mandara*, about 63 × 37 ft. This court had a colonnade roof along the south side, resting on nine columns, and shading about half of the court. Facing the north, this space caught the wind, and served for the general place for open-air reception and affairs, such as is needed during most of the year in Egypt. A stairway projecting from the end led up to the roof of the house, and served to screen off wind from the entrance to the master's rooms.

A doorway at the end of the court led to the more private rooms of the family, to which even the servants had no access without going through the public court. Here was a court about 32 ft. square, with a central tank and columns round it, four on a side: this was similar to the peristyle of the private apartments in a Roman mansion, but with the tank of the atrium in the centre. Doubtless the roof was open over the tank, and this would be the centre of family life. Five large rooms to the north were probably for stores. To the south is the master's private sitting room, about 24 × 14 ft., with a column in the middle; only from this could four other rooms be reached, and these would be the master's bedroom (18 × 9 ft.) and three smaller store-rooms for the use of the master and mistress.

Returning to the public part of the house, another door led from the entrance to a corridor 93 ft. long and 8 ft.

wide, and, passing through a lesser hall with one column, the winter reception room was reached, about 25 ft. square, with four columns. Opening from this was a group of six rooms, probably for the more general use of the family, and for visitors' rooms.

A passage from these public rooms led into the men servants' quarters, which were also reached from the main entrance. Here was a hall, 29 × 25 ft., probably open to the sky on the north, with a tank and a half-roof colonnade, with two columns along the south side. From this branched off three sets of rooms by different entrances. One set of five rooms, with stairways leading to upper rooms, were probably for servants' sleeping quarters. Another set of six smaller rooms were for food and stores, and three other rooms close to the south wall were for actual cooking. In one house the cook-places were found at the south wall, the object being to prevent the prevalent north wind from carrying the smoke and smell toward the living rooms.

Quite apart from the rest of the house, and only reached by a front and a back door, was the block of women's apartments, the *gynaeceum*. The importance of this quarter depended on the domestic economy of the age. All the weaving and sewing of the large household were done here, all the washing and the starching so essential to the decorative dress of that period, the training of servants, and teaching of music and other feminine arts. At the north there was a hall, about 24 ft. square, with a tank, probably half covered by a colonnade of three columns along the south side. Six store-rooms lay to the north end. Twelve other rooms were to the south for the working and sleeping quarters of the staff of girls, probably equal in number to the men and lads who did the heavier and more public work of the large establishment. Seventy large halls and rooms must have needed a large staff to clean them and keep them tidy. Such was the

internal system of a great official's house as shewn in the xiith dynasty. Half a dozen such officials were employed for the erection of a pyramid.

VILLAS. We now turn to another aspect, in the villas of the bureaucracy of the xviiith dynasty. These were built under very different conditions from that of the compact town of Kahūn. When Akhenaten started his new capital at Tell el Amarna, the wide expanse of desert was divided in allotments, the boundaries of which were marked with big rolled flints with the owner's name written in ink. The plots were generally enclosed by a brick wall. There was plenty of free space in the desert, and the villas of the officials were built to suit personal requirements, though all on one system of parts and positions. The space covered by the building was between 30 ft. and 60 ft. square. The most complete house of this type we will now describe (133).

The flight of steps of approach, A, is usually on the north side of the house, sometimes on east or west, but never south. They were about 17 ins. in the tread, and 2 to 2½ in the rise. The entrance is in a porch, P, where the doorkeeper would sit, and where he probably slept. This led to a lobby, Y, about 8 × 10 ft., on the way to the *loggia*, L, which was doubtless open to the north along the upper part of the wall, with a framed lattice, as seen in many views of halls. This *loggia* varied from 17 × 8 ft. to 26 × 15 ft., with two columns to carry the roof. At the end of it is a room, O, probably for visitors. A door in the side of the *loggia* led into the central hall from 15 to 24 ft. square. Here there is laid a low platform or *mastaba* for the master to sit on, always facing the entrance, and with the fire pan before it. The roof is carried by a central column, sometimes by two columns.

On the left hand of the *mastaba* is the doorway to the master's rooms, B.C. The furthest of these is the largest closed room in the house, varying from 7½ × 13 ft. to

16 × 17 ft. It has always a rather narrower raised floor at the south end for the bed place. The entrance chamber which leads to this has from two to five other rooms opening from it, which were doubtless for the women servants.

On the right hand of the *mastaba* is another door, which opens on a smaller hall (1), usually with one column. This hall is from 11½ ft. square to 13 × 16 ft., and two or three small rooms open from it. This is the men servants' quarter, with their living hall and sleeping rooms.

On the other side of the central hall are store-rooms (T.U.), and a stair (S) that led up to the roof. The space below the stair was often occupied by cupboards. Such was the system for the houses of ten to twenty rooms belonging to the well-to-do official class of the xviiith dynasty.

68. PALACE. As another class of dwelling, we may take the palace of the xxvith dynasty at Memphis (134) (*The Palace of Apries*, p. 1). This was on a great scale, covering over two acres; but the space was filled by the enormous size of a few parts, and not by a multitude of chambers. It was only needed for the personal service of the king and his family, the stores and guards being placed in other buildings. In all this area there are but twenty halls, and no small chambers.

The plan as a whole is exactly on the lines of the great mansions of the xiith dynasty. The entrance is to the south; the main passage leads through to the great *mandara* court on the north. On the west, south of the *mandara*, is the great winter court; south of that are the kitchen and servants' quarters. To the east of the main passage lie the halls of the women's quarter, and there also probably the king lived, as in the palace there is no parallel to the group of the master's rooms of the xiith dynasty mansions.

The *mandara*, or open reception court, has been largely denuded away at the north end, but we can still see that it was 178 ft. long. The capitals of the great palm columns, which carried the roof along the southern side, are still lying on the spot; from them we gather that it was about 45 ft. high.

South of this were six store-chambers, each 35 ft. long. Beyond them was the great court for winter use, 107 × 115 ft., the roof of which was carried by columns about 40 ft. high, probably sixteen in number. Further south were the offices and kitchen; the very thick walls (19 to 22 ft.), to the south-west, were probably the base of a tower. In this part also was the guard room, opening on the entrance passage. This passage was about 20 ft. wide, and formerly led straight to the palace, but it had been blocked at a later time, and the entry was only by the *harem* passage on the east, crossing the berm and a deep fosse.

On the east were the private halls of the king and *harem*, three of 43 × 23 ft., four others of 20 × 22 ft. They were paved with two courses of great blocks of limestone, and had a dado of limestone 8 ins. thick and 3½ ft. high. The slabs were up to 10 ft. long. Above this was a white plastered wall.

The bulk of the structure was all of crude brick, the walls about 12 ft. thick. They rose about 45 ft. above the platform, and ran down below that for more than 45 ft. to form the substructure. To the south of the palace was a fosse dividing the platform from other great buildings, through which the approach ran up to the palace level. These buildings have been completely removed by the digging of earth for the fields.

69. TOWN HOUSE, xviiith dyn. The sectional view of a house is well given at Thebes (135). On the ground floor is a weaving factory with vertical looms, and the spinning and the dressing of the finished linen. On the

first floor sits the owner with food and drink brought to him. Upstairs on the second floor he sits again, fanned, and with his scribe squatting before him, while grain and various goods are brought up to the store-rooms and the granaries on the roof. The floors appear to be built with joists, boarding, and ceilings. This house was probably a town house, built higher than was usual in the country, where land was cheap.

70. TEMPLES were of various types, connected with different forms of service. The chambers for the divine figures (A), side by side, are the oldest; the processional type (B) for carrying out the barque of the god was of the xviiith dynasty; the solid box shrine (C) for one sacred statue was usual in late times. Beside these, a different type (D) grew from the tomb chapel of the kings. All the plans here are to the same scale, 1 : 800.

The oldest complete cellular plan is the small temple built by Khufu (136), in which his ivory statuette was found. It has the peculiar entrance like the offering court of Sneferu (137), an outer door to one side of the front, then one to the other side, and lastly a middle door. The inner chamber is 17 ft. wide and 6 ft. across; of three cells side by side at the back, the middle one was the shrine of the god with a recessed door, the others may have been for other deities. For storage there was only a long passage, a couple of feet wide and twenty long, just to hold a row of vases and utensils. A larger sanctuary is of the vith dynasty, also with three cells (138), the front chamber being again entered at one end. Buried in one of the chambers were the bronze figures of Pepy, and the hawk with gold head; damaged *sacra* were thus disposed of, when the shrine was covered over by a later temple.

Another growth of this type, on a very expanded scale, is the temple of Sety I at Abydos (139), with a row of seven cells for as many deities. The little primitive chambers of Khufu were the origin of large halls of

columns, and one cell led back into a wide complex of building behind the cells. The plan drawn here is what the original design seems to have been; but the narrower portion was actually transferred to the side of the temple, in order to fit the site.

71. PROCESSIONAL TEMPLES. In the xviiith to xxth dynasties, the festivals were celebrated by processions bearing the ark of the god upon a barque, and this made it needful to have a shrine for the barque, open at both ends for the procession to pass, so as to deposit the ark on the central stand and then file out at the back and return outside. The examples of this are at Medinet Habu (built from Amenhetep I to Tehutmes III, fig. 140), Aswan (built by Tehutmes III, sculptured by Amenhetep III, fig. 141), and the temple of Khonsu at Thebes (142, built by Ramessu III). The two earlier examples have an open colonnade around the shrine, but in the later temple the shrine is hidden in a nest of chambers. The latest example is that of Philip Arrhidaeos at Luqsor, which probably superseded a shrine of the xviiith dynasty. Within such a shrine there must have been a stand, shoulder high, to rest the barque upon, when the priests withdrew the staves and left it. Such a stand is preserved in the British Museum, a granite block with figures of gods around it (Belzoni, *Travels*, 107).

72. SHRINE TEMPLES. The later temples usually contained a single box-shaped upright shrine, which was closed by locked doors, and was often a monolith. Such are seen in the Delta at Mendes, Saft, and Nebesheh, and another such shrine from the southern Athribis was cut into paving slabs for the White Monastery at Sohāg.

The shrine at Edfu (143) is built of blocks, and measures 34 × 55 ft. That at Dendereh is similar.

The temple of Edfu is a good example of successive addition. The box shrine has a portico of 12 columns, and was complete, as the outer wall of it ends in a torus

roll at the corners. In front of that, a larger portico of 18 columns was added. Yet further in front was the open peristyle court with 34 columns, and around the whole is the fortification of a high wall and immense pylon.

73. Turning now to the ROYAL TOMB TEMPLES, the earliest is that of Khufu, which has never been surveyed. The next is that of Khafra (144), the earliest large plan preserved. The ascent from the granite temple enters askew, controlled by the shape of the ground. There comes first a varied version of the lower granite temple, a wide hall leading to a long, narrow, colonnade hall. This leads to the great court with statues around, and, behind it, five long halls all alike. These seem to have a special significance, as there are five halls in the Hierakonpolis temple of the Old Kingdom : possibly consecrated to the five divinities of the Osiris family. A side passage leads round to another group of five halls at the back, and lastly, against the back wall, is the place of the great funeral stele in the axis of the temple. The ritual of these several halls has not yet been recovered.

74. The temple of MENKAURA (145) has been left incomplete, added to largely by his son Shepseskaf with brick walls ; then, after a time of neglect, Mer-ne-ra of the VIth dynasty remodelled the chambers near the pyramid face, using very coarse nummulitic limestone.

So far as the details are clear, the temple of Menkaura can be identified in the entrance avenue lined with black granite, the great court also with black granite, the hall of six pillars lined with red granite, and the corridor continuing west of it. The narrow passage on the north of this is lined with black granite ; the four small chambers north of that are reconstructed, probably on old lines. Proceeding up to the pyramid face, the place of the great funeral stele is obvious in the foundation, where the outline of an early court is seen by the pavement of red granite. The wide hall of six columns is a later work, as

broken offering-vases of the old temple were beneath the floor.

Thus the original plan of Menkaura is practically complete, as far as the great enclosure wall of Shepseskaf, built of mud brick. All west of this is so much altered that no details of chambers are original.

75. On reaching the VTH DYNASTY, we see a very different plan for the temple of Sahura (146), where an axial chamber has, along the back of it, five shrines. Behind this is the long chamber with the funeral stele at the back.

Next in that dynasty, for Nefer-ar-ka-ra (147), the entrance hall and great atrium of columns is as before, but it is not centred on the pyramid ; the five parallel halls are brought close up to the pyramid face.

Still later, Ne-user-ra (148) continued a similar hall of approach, and the square peristyle court ; behind this there are the five shrines in a row, and the larger chamber, behind these again, was probably for the funeral stele.

The plans of pyramid temples are given here in full, as they show how a fundamental type, for a single purpose, was retained, and varieties adopted as required. There is no such closely related series to be found in any other period, and they demonstrate the flexibility of ideas in the architecture of the Pyramid Age.

Two thousand years later, Ramessu I (149) abandoned the early type of building. His temple stood unfinished at his death, and was altered by Ramessu II to serve for Sety I. The great Ramesseum was begun by Sety I for himself, but was appropriated by his son.

76. TOMB STRUCTURES. The earliest surface monument known above a tomb is the flat mound, retained by a brick wall, which covered royal burials of the Ist dynasty. Private tombs also had a square mound, with a vertical slit in the side where funeral offerings were presented ; this slit was fenced in front by a low wall, and by the

enclosure were piled the rough pottery vessels used for offerings (fig. 150). A lesser form of monument was a barrel-roofed pile with raised bands across it, plastered white and blue (151).

The standard tomb in the ivth–vith dynasties was of plain stone with sloping sides and flat top, the usual *mastaba* (152), which included chambers for statues and offerings.

The largest form of tomb was the brickwork copy of the chief's house of wooden planks (see figs. 27–32). For a small copy of this, see fig. 153; it is about 13 × 16 ft. surrounded by a fender wall, and it stood above the funeral chamber, which was entered by a pit and passage. The doorways modelled on the outside were capped by a stone slab, carved with a figure of the deceased accepting his funeral offerings. Of the xiith dynasty, and later times, there are very few surface monuments recorded.

In the xth dynasty, a new type of tomb was formed by building in front of a rock chamber, beneath which a passage led to the burial. This was a Nubian type, copied from temples. The temple at Es Sebua (154) had an open forecourt, and behind that a roofed hall with 12 pillars, which led to a cross-hall; from that there opened out a chamber at each end, and three chambers at the back. Of the same type is the tomb of Uahka (155), except that, being in sound rock, no pillars were needed in the hall.

This type led to the great rock halls of tombs of the xiith dynasty, in which there was no construction but only excavation, copying the columns and roofs of the dwelling house. The excavation of these tombs provided the blocks for the masonry of the houses of the living.

In Roman times, brick chambers in the cemetery were used for the funeral feasts at the graves. For the fuller account of the varieties of the tomb and its service, see the catalogue volume, *Funeral Furniture*, lately published.

In the foregoing summary of architectural origins and development, covering a period of about five thousand years, I have tried to view the subject as the ancient Egyptians did, and to take into account the materials, the practical methods of construction, and the purposes behind the system. We need to observe the ingenuity of the architects in reaching a result, their triumph over apparent limitations, and the harmony of their design with the country and conditions. I have tabulated the various limits of the proportion and scale of the parts, in order to realise how freely the variations were adopted, and how continuous was the development throughout the ages.

BRITISH SCHOOL OF EGYPTIAN ARCHÆOLOGY

THE last few winters have been actively employed in excavation in the coasts of Palestine and Sinai, and the summers in researches consequent on these.

A fourth and a fifth season at Ancient Gaza have yielded good results. Three seasons on a border fortress at Anthedon exposed twelve layers of frontier town of as many centuries ; the sequence of the finds illustrated the political conditions and the fluctuations of prosperity of each reign.

Shorter spells of work included surface examinations in Syria and Moab, and a brief digging at Petra.

In these labours, however, we have been hampered by a falling off of funds, due to the decrease of personal intercourse with England and the enforced cessation of our college lectures, lantern lectures, and annual exhibitions.

Help is urgently needed, therefore, that the present difficulties of our work in Palestine be not increased by a lack of resources.

H. PETRIE,
Jerusalem.

Address : Lady Petrie,
University College,
Gower Street, London, W.C.1.

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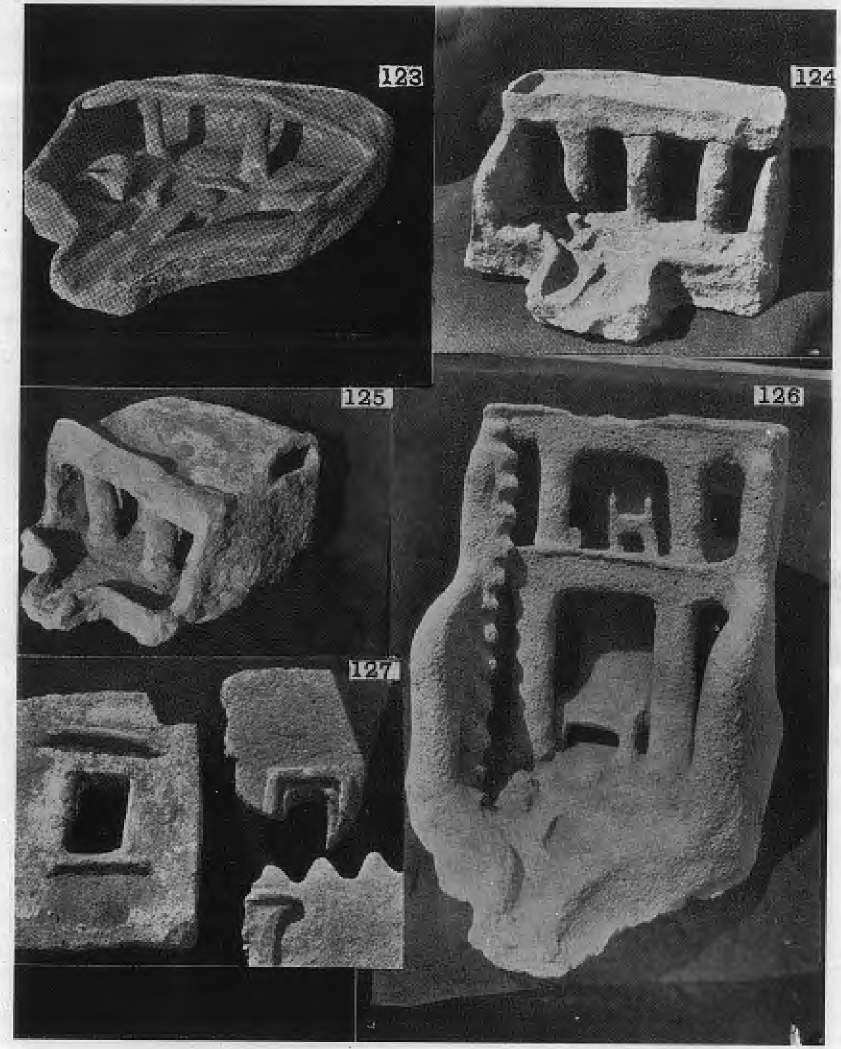
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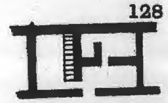

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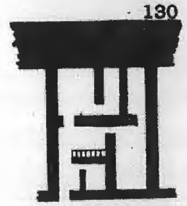

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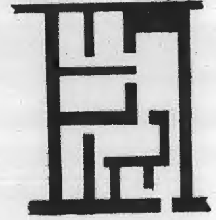

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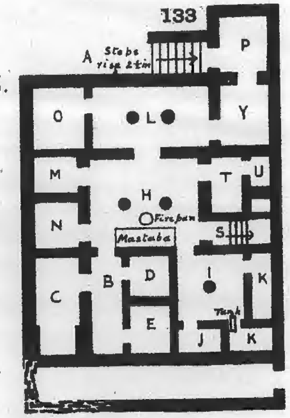

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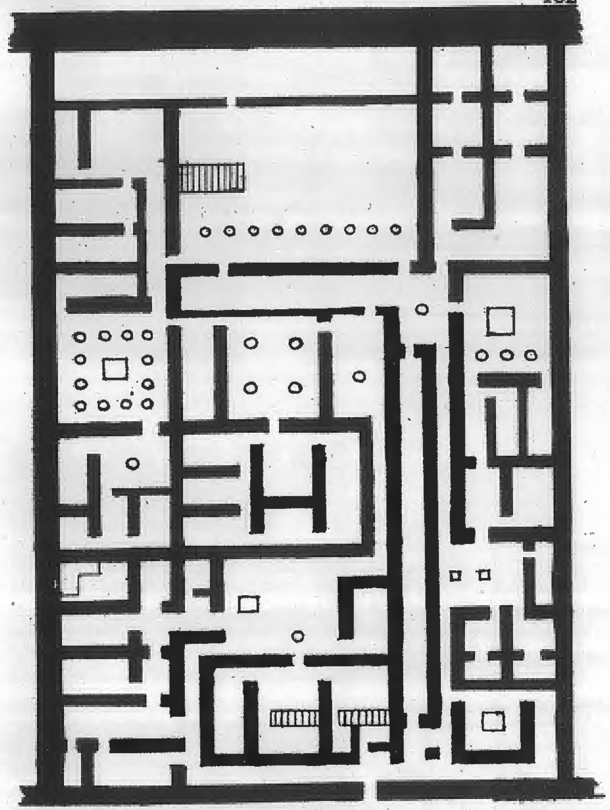

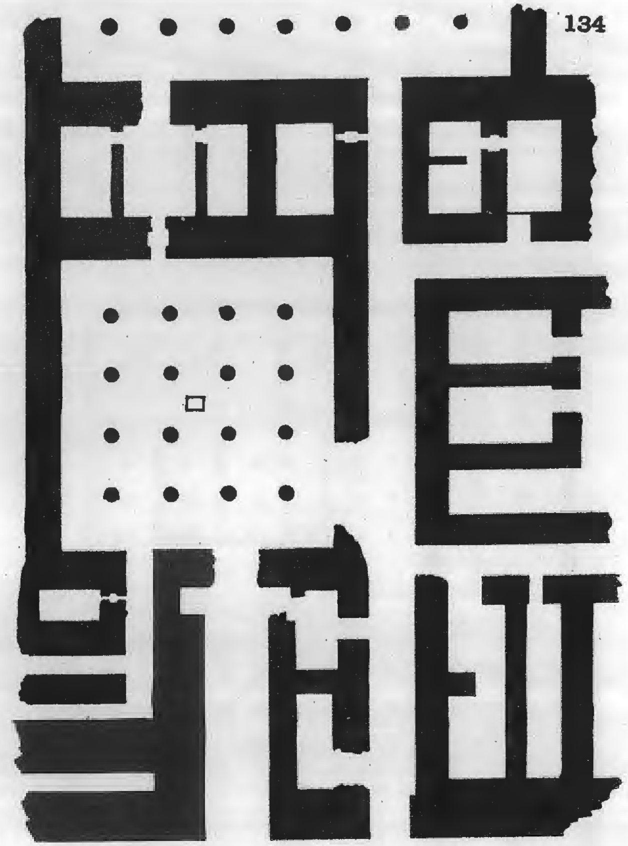

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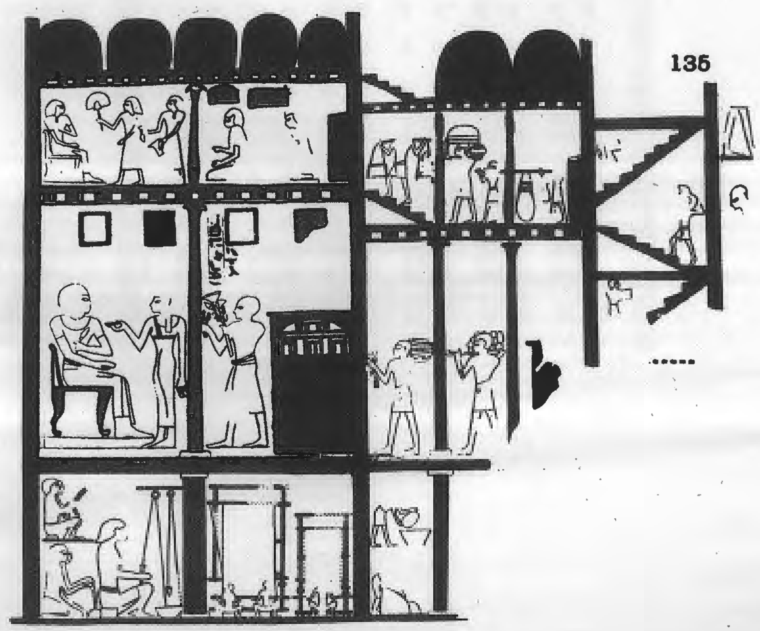

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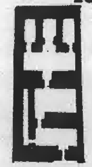

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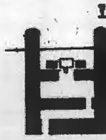

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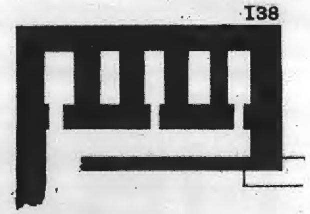

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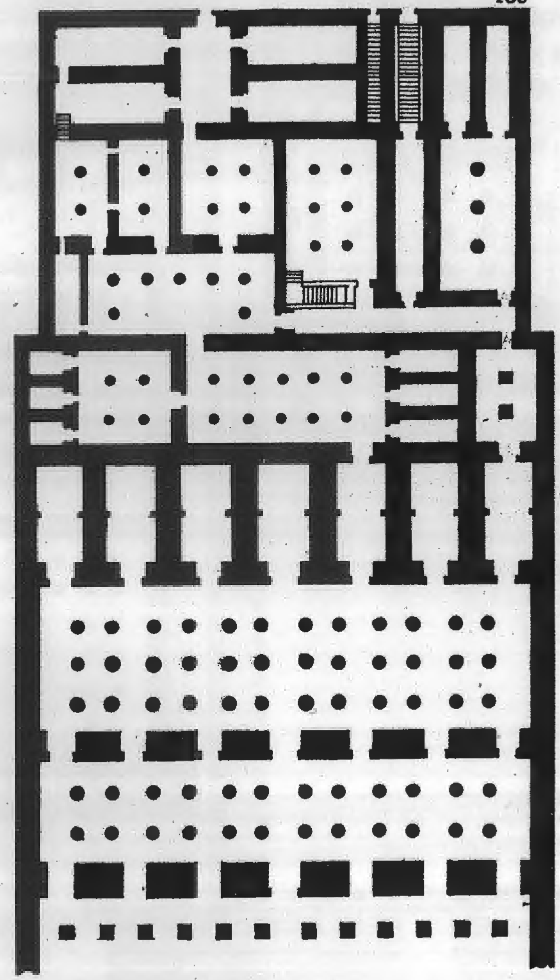

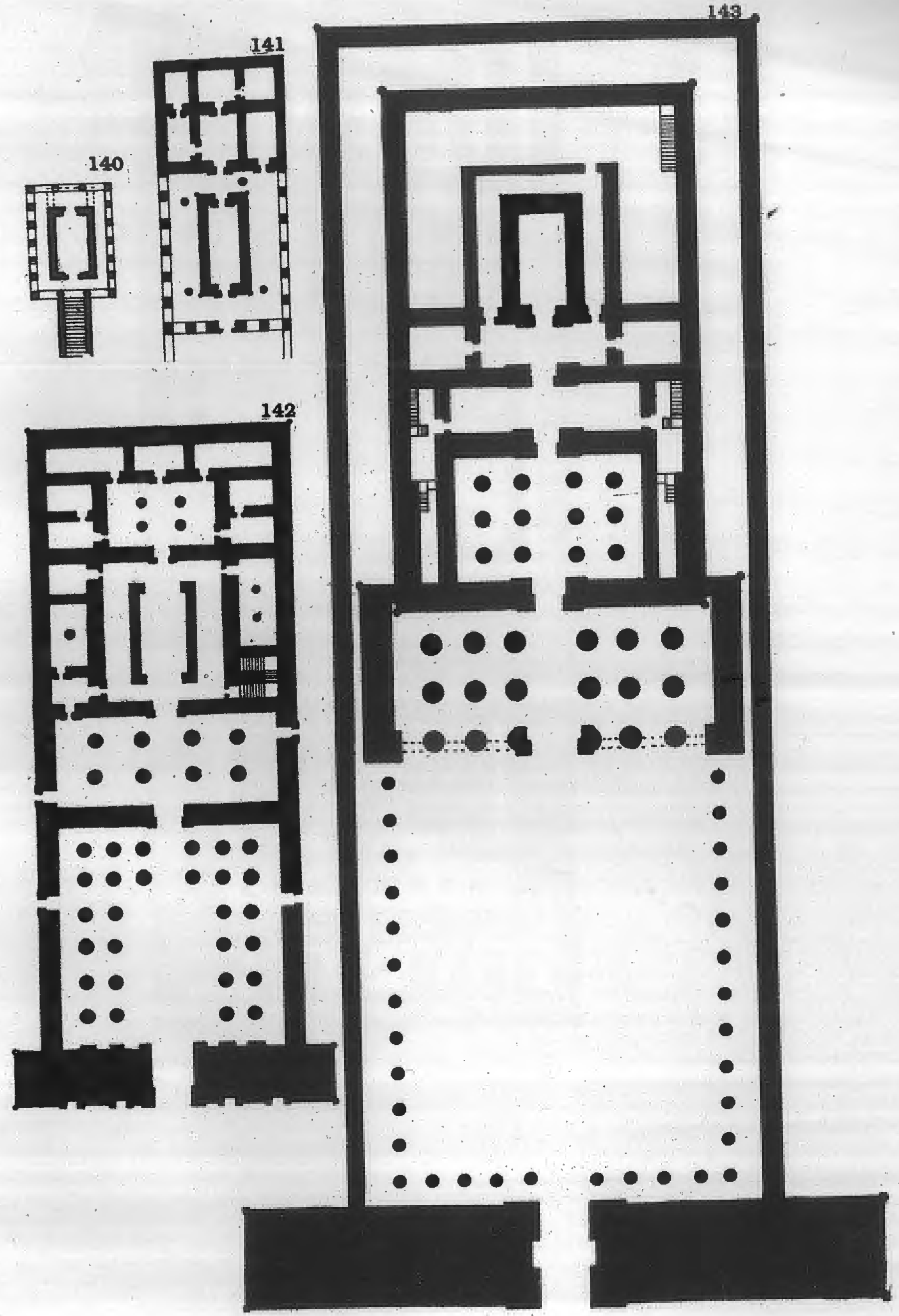
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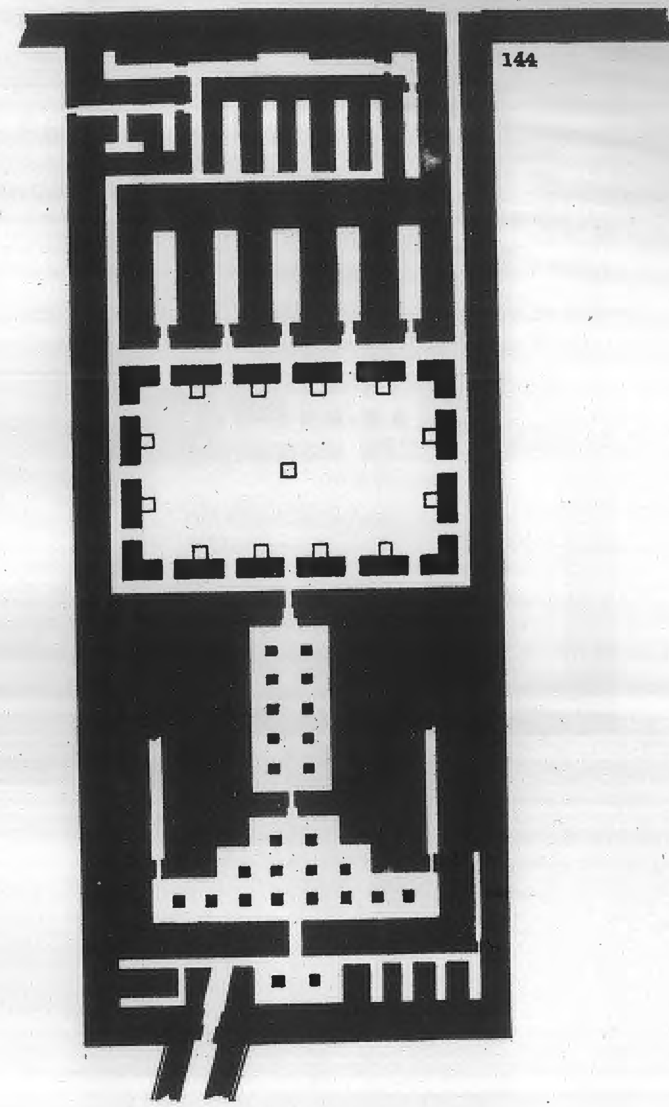

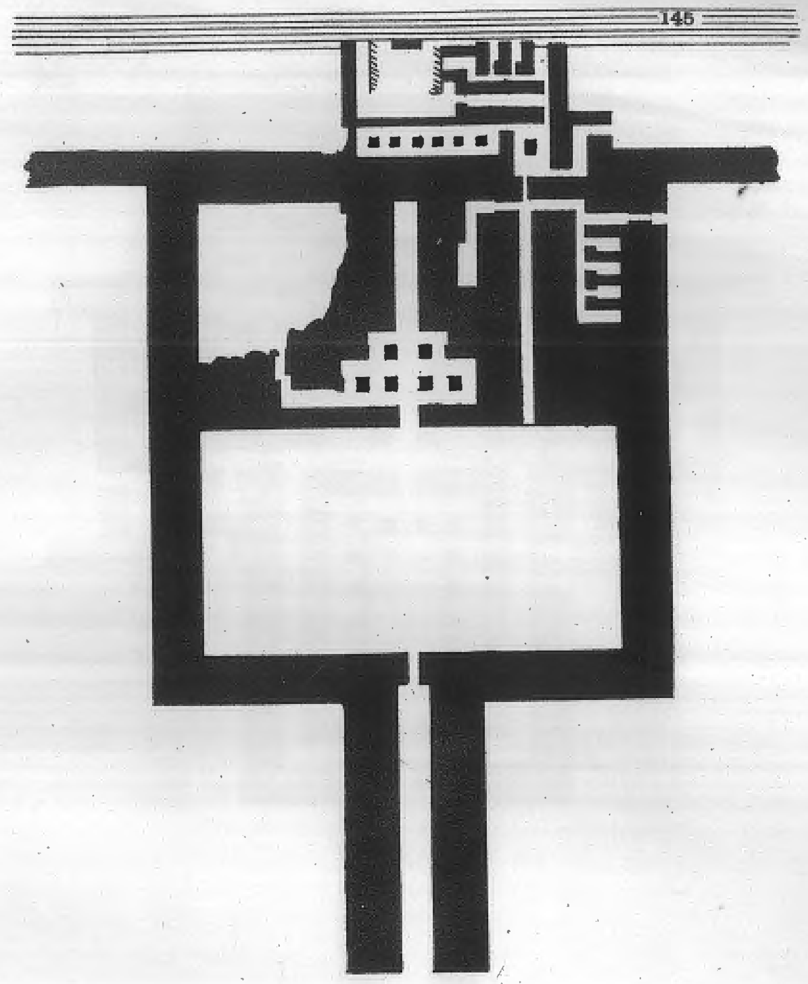
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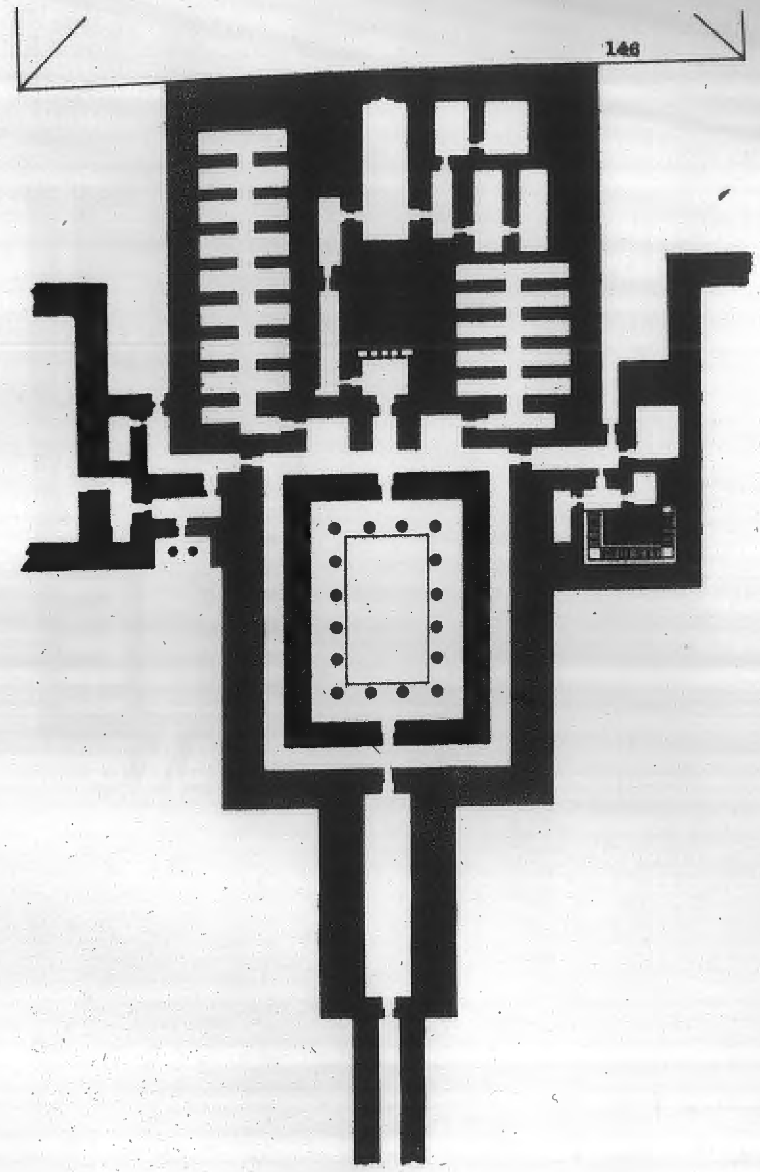
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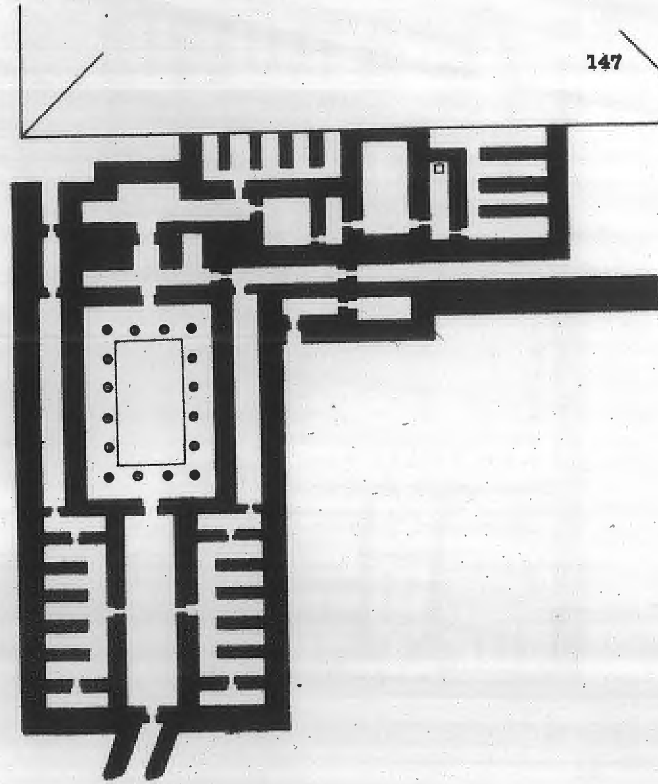
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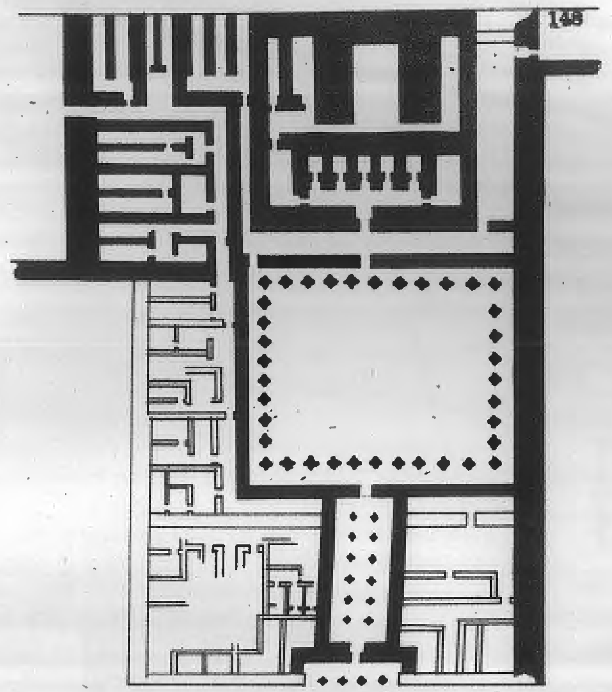

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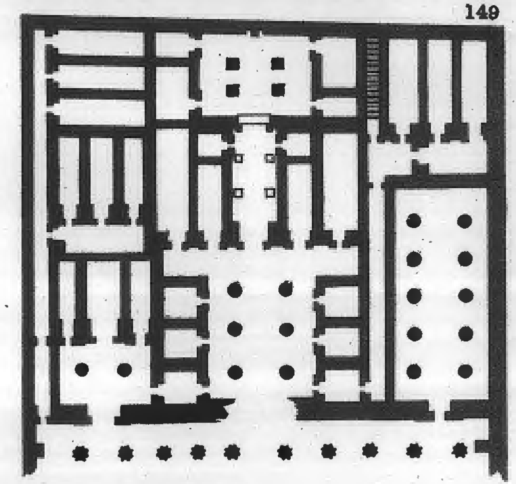

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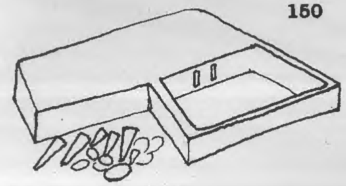

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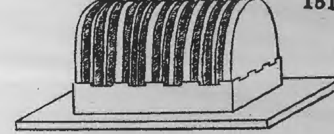

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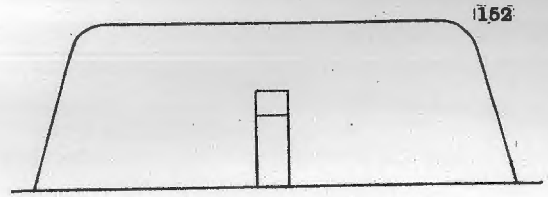

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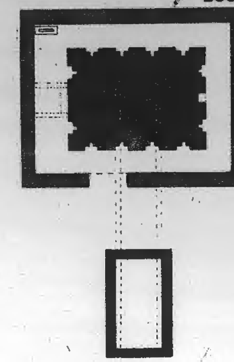

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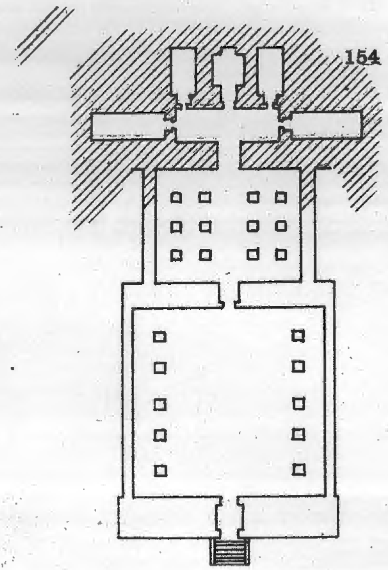

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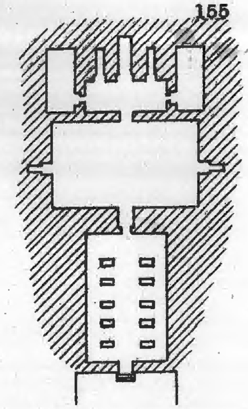

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